Engineering News

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Rebuilding Elevated Railways in New York City--I

SYNOPSIS—Adding a third track for express service on the elevated railways of Manhattan and Bronx boroughs, New York, made extensive rebuilding of the structure necessary. The work involves about 50,000 tons of steel, and had to be done under traffic. Different station types are used, the principal ones being the mezzanine and hump type.

Most of the 37-mi. network of rapid-transit elevated railway in the Boroughs of Manhattan and Bronx, New York City, all originally built double-track, is being reconstructed by adding a third track for express-train service. Some lines were equipped with a third track a number of years ago, notably the Ninth Ave. line, on which expresses have been operated since that time in a no-stop run from 14th St. to 116th St., about five miles. This early third-tracking, however, has little effect in reducing the magnitude of the present enterprise, because the work, while primarily consisting of adding a track to the elevated structure, involves a great deal more:

Complete or nearly complete replacement of present two-track structure at certain locations by new structure carrying from three to five tracks; removal of all present center platforms, so as to permit the carrying through of the center track; remodeling a large number of stations to serve the express traffic, which generally includes reconstruction of structure for a distance of about 1700 ft.; replacement of a two-track swing span and two end spans with a double-deck four-track bridge; and rearrangement of running tracks, at one point even raising the running tracks 7 ft. and at another shifting the track with its supporting girders 13 ft. sidewise; all the work be-

FIG. 1. DOUBLE-DECKING THE SOUTH FERRY LINE IN NEW BOWERY, MANHATTAN BOROUGH, NEW YORK CITY

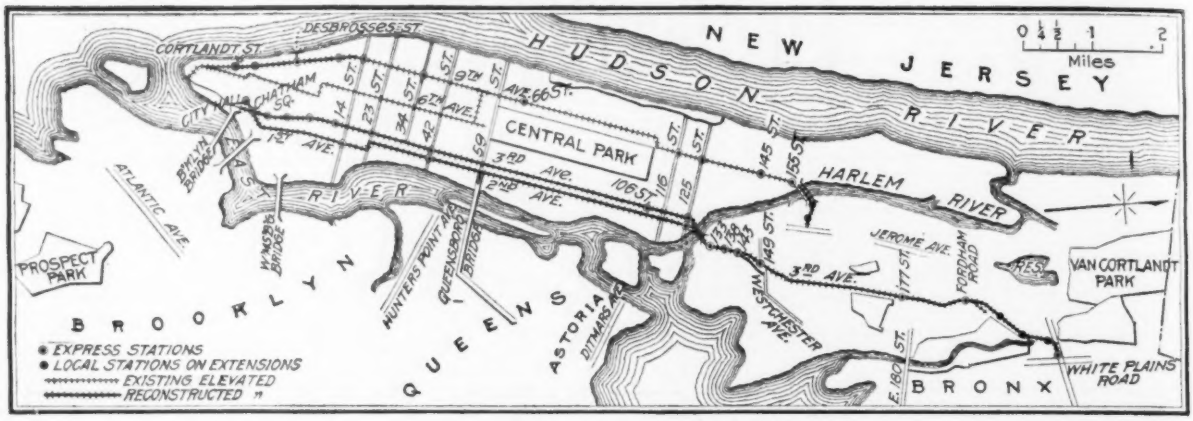


FIG. 2. ELEVATED-RAILWAY SYSTEM OF THE BOROUGHS OF MANHATTAN AND BRONX, NEW YORK CITY

ing accomplished without interfering with the proper running of the trains, which carry over one million passengers a day.

Complicating the whole problem, three important grade crossings or track junctions are being rebuilt with separation of grade and routes, involving much new structure, double-decking, revision of trackage, etc.

The undertaking is of such magnitude that it may be considered virtually a reconstruction of the entire elevated system of the Manhattan Railway Co. The work is described in a summary way in the present article. The reconstruction is being carried out by T. A. Gillespie Co., Terry & Tench, and Snare & Triest, contractors, under the supervision of the Interborough Rapid Transit Co., lessee of the Manhattan Railway Co. lines under a 999-year lease. The plans for the work received the formal approval of the Public Service Commission, but were developed wholly in the Interborough engineering department.

Planned Fifteen Years Ago

A dozen or more years ago the Manhattan Railway Co. entertained the idea of fitting all its lines with third track for express-train operation—southward in the morning rush hours, northward in the evening rush hours, express trains in both cases to return over the local tracks. The feasibility of the project was investigated at that time, the old structure and its possibilities in the way of carrying additional loads and suitability for reinforceng were thoroughly canvassed, and designs were developed for a considerable part of the work. However, for various reasons the work was not carried any farther then.

Five years ago, when the city authorities in negotiating for new rapid-transit construction asked for inclusion of third-tracking proposals, the plan was taken up anew. The agreement between the city and the Interborough, reached in March, 1913, included the third-tracking of the elevated lines as an essential feature. Not long afterward the Public Service Commission issued formal authorization for the work, which has been carried forward actively since then to the point where erection is in progress on practically every section of the undertaking.

Work Done Under Traffic

The most important condition of the work was that the dense traffic—averaging about 300 trains per day per track—must be maintained at all times, without interruption or risk, and with the minimum inconvenience to passengers and disarrangement of schedules. This meant piecemeal work, the adoption of cutting and fitting methods in place of complete reconstruction in many instances, and sometimes the adoption of radically unusual designs or procedures.

On the map, Fig. 2, the four lines in Manhattan, one of them extending into Bronx Borough, are indicated. Each of the four lines was double-track, except for three tracks on the Ninth Ave. line from 12th St. to 159th St. (between 114th and 127th St. there were only two tracks), and on a portion of the Third Ave. line. As reconstructed, the system will have three tracks everywhere except on the Sixth Ave. line, and four or five tracks in the vicinity of the Chatham Square junction and between 125th and 145th St. on the Second Ave. and Third Ave. lines.

Other prominent elements of the system as rebuilt are: Station reconstruction on the remainder of the Ninth Ave. line north of Christopher St. to suit the new express-operating system; double-decking along Park Row on the Third Ave. line to provide four tracks entering City Hall station from Chatham Square station, and similar double-decking on the Second Ave. line from Franklin Square to Chatham Square station to correspond with the

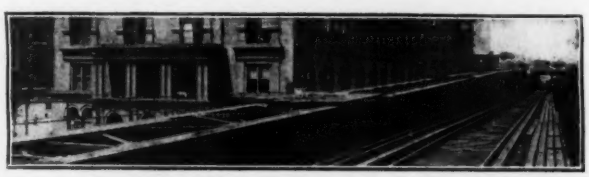


FIG. 3. TRACK INCLINE TO "HUMP" EXPRESS STATION, NINTH ST. STATION OF THIRD AVE. LINE

FIG. 4. MEZZANINE CONCOURSE OF ISLAND-PLATFORM STATION, 42ND ST. STATION OF SECOND AVE. LINE

elimination of grade crossing at Chatham Square; complete rebuilding and double-decking of Chatham Square station to separate crossing tracks; rebuilding the entire structure for five tracks to near Canal St. and for three tracks north of this point; third-tracking and station revision northward on Third Ave. to the Harlem River bridge; third-tracking and provision of express stations on the Second Ave. line from Chatham Square to 125th St., and removal of the 127th St. station to 125th St.; revision of track and double-decking thence north to Harlem River bridge; replacement of the entire Harlem River bridge by a double-deck structure, giving four tracks total; four-tracking and station revision to 145th St. in the Bronx, and third-tracking thence north to the end of the line at Bronx Park.

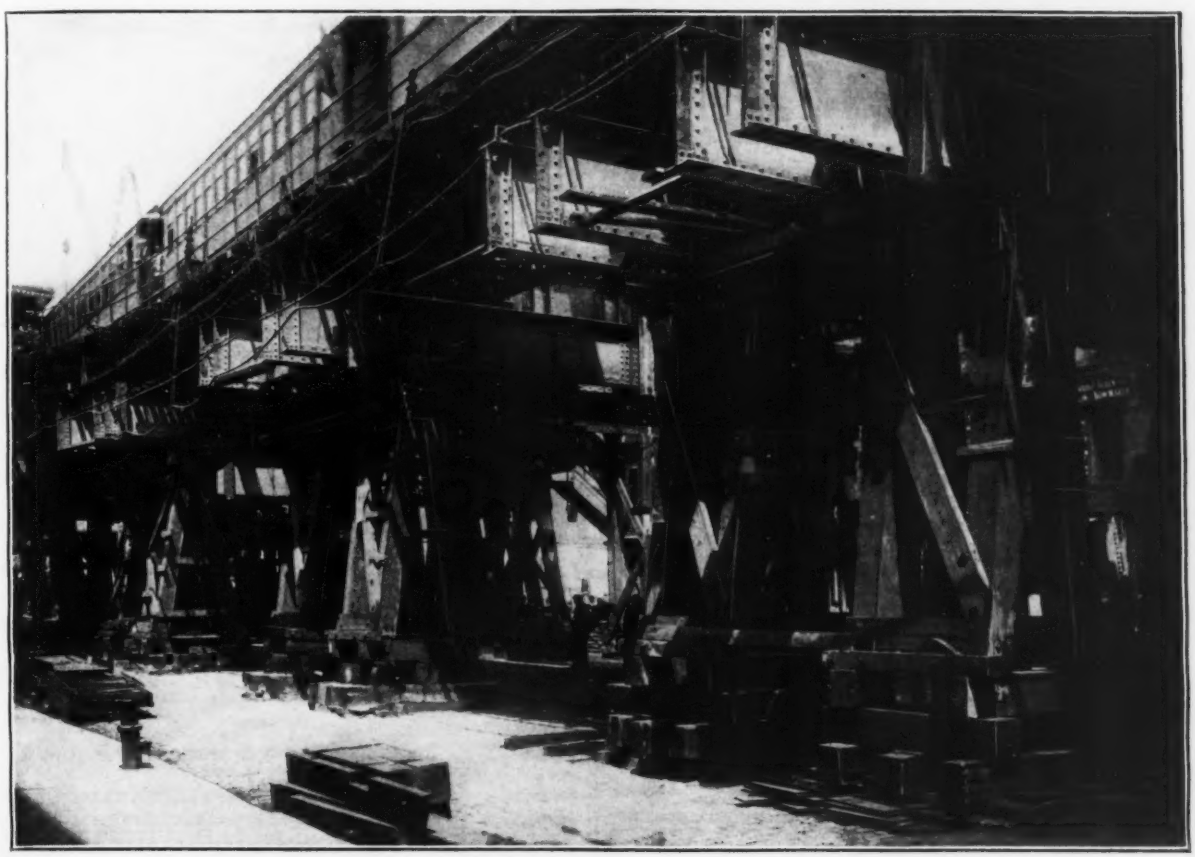


FIG. 5. TYPICAL SHORING WITH NEEDLE BEAMS; ELEVATED-RAILWAY RECONSTRUCTION
Needle beams required here for supporting center-track girders

General Conditions of Reconstruction

Most of the old elevated structure consists of transverse bents comprising two columns and a plate-girder or truss, spaced generally 42 to 45 ft. apart along the line, carrying longitudinal girders—one per rail—on which the track ties are laid. At individual points where the structure is high above the street successive pairs of bents are braced together by longitudinal portal bracing to form four-column towers.

Most of this two-column construction had been built originally with tracks spread sufficiently to admit a future center track. In some places the cross-girders of the bents had even been punched for the connection of the future track girders. However, on parts of the line the cross-girders were not strong enough to carry the additional track with modern loading—the present-day electric elevated trains, as compared with the much smaller and lighter cars and light steam locomotives of twenty years ago. It was necessary to remove these girders and replace them by stronger ones, and in many cases also to renew the columns.

Single-Track and One-Column Construction

Single-track or one-column construction (see sketches E and J, Fig. 6) existed on a few lines, notably on the Bowery and New Bowery (Third Ave. line) and on Greenwich St. (Ninth Ave. line). The columns, set just inside the curb line, on the sidewalk were built with a spread cap carrying a pair of track girders of suitable spacing for one track. In some instances the two single-track structures, one on each side of the street, were braced together by transverse struts, but in the main they relied for lateral stiffness upon the fixity of the columns on their brick foundation piers.

The treatment suitable for the several cases of single-track construction depended upon the layout of the new work. Throughout the length of the Bowery it has been necessary to build an entirely new structure occupying the middle of the street and to abandon the old structure completely with only local exceptions, where the original column locations could be used. On Greenwich St., however, the old column locations and in fact many of the

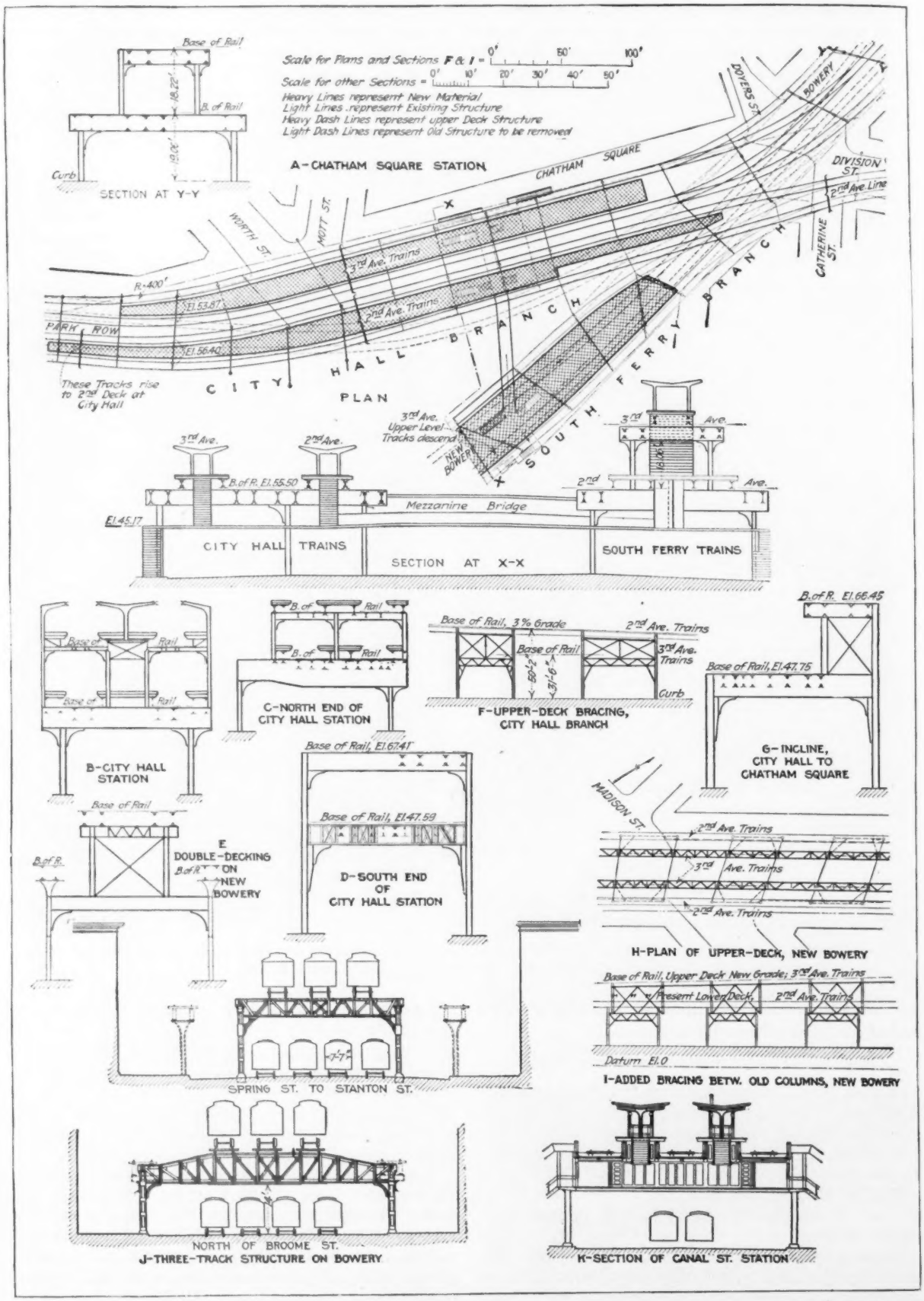


FIG. 6. TYPICAL SKETCHES OF NEW YORK ELEVATED-RAILWAY RECONSTRUCTION, SOUTH PORTION

old columns themselves are retained throughout and cross-girders are slipped in between the old track stringers, carrying them as well as the new set of middle track girders. When the new work is completed there will be none of the single-column structure remaining in service.

Express Stations: Mezzanine and Hump Types

How to reach the new center track with station platforms (at express stations) was one of the essential problems of the enterprise.

Two main types of station were worked out as solutions of this problem—(1) the island-platform or mezzanine station type, and (2) the double-deck station or "hump" type.

(1) The island-platform stations, in which the platforms are between the tracks and are reached by stairs, have the station booths and concourse on a mezzanine floor between street and track level. Sketch A in Fig. 6 and the view, Fig. 4, show such stations.

This type was used where the tracks were far enough apart or could be spread to admit the island platforms. The structure was high enough, at most of the stations, to admit of building the mezzanine floor and yet leave sufficient street clearance; but at several stations the structure had to be raised to make room for the mezzanine, by amounts ranging up to 7 ft.

(2) The "hump" type of station, produced by raising the center track about 11 ft. at and near the station, with express platforms located directly over the local tracks, and local platforms outside the local tracks, has an important advantage in not requiring more width of ground area than the previously existing local station. Also, it is the cheapest solution where the center track already exists or where the existing structure is wide enough only for third track without island platforms. The circumstances of the old elevated structure were such that the hump type proved best for a number of locations—see for example the view, Fig. 3.

A determining factor in deciding between mezzanine and hump station was the matter of easement damages to abutting property. Where there was reason to apprehend large claims for damages if the elevated structure were widened for island platforms, the hump type was adopted, as involving least disturbance of the property status.

The principal station type other than the two above noted is that employed at Greenwich St., on the Ninth Ave. line. Here the old tracks were spaced far enough to admit a third track and a single island platform—the old outside platforms being continued in service. However, the structure was not high enough to admit a mezzanine for reaching the express (island) platform. Therefore a bridge over the tracks was constructed, with stairs to all three platforms, allowing access to the island platform from either local platform.

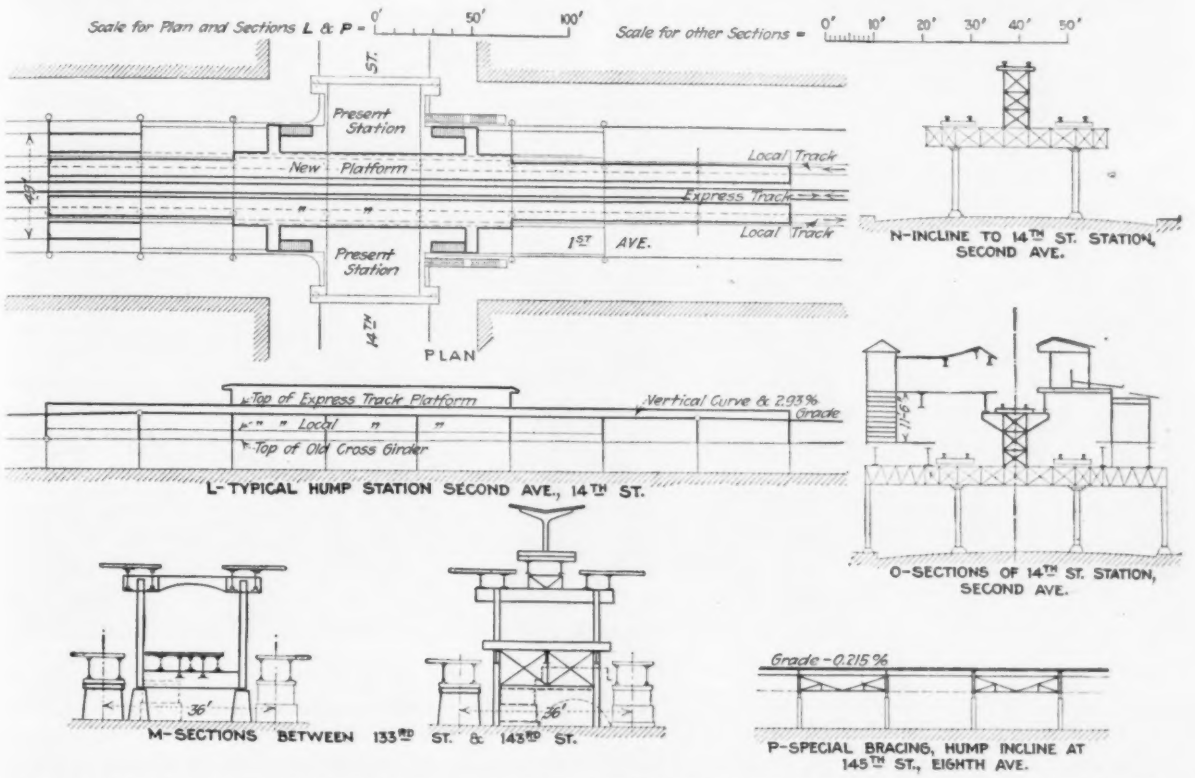

Scale for Plan and Sections L & P = 0' 50' 100'
Scale for other Sections = 0' 10' 20' 30' 40' 50'
Present Station
New Platform
Local Track
Express Track
Local Track
1ST AVE.
Present Station
14TH
PLAN
N-INCLINE TO 14TH ST. STATION, SECOND AVE.
Top of Express Track Platform
" " Local "
Top of Old Cross Girder
Vertical Curve & 2.93% Grade
L-TYPICAL HUMP STATION SECOND AVE., 14TH ST.
O-SECTIONS OF 14TH ST. STATION, SECOND AVE.
36'
36'
M-SECTIONS BETWEEN 133RD ST. & 143RD ST.
Grade - 0.215%
P-SPECIAL BRACING, HUMP INCLINE AT 145TH ST., EIGHTH AVE.

FIG. 7. HUMP STATION CONSTRUCTION AND DOUBLE-DECK WORK ON BRONX BOROUGH ELEVATED LINES

An Ingenious Station Arrangement

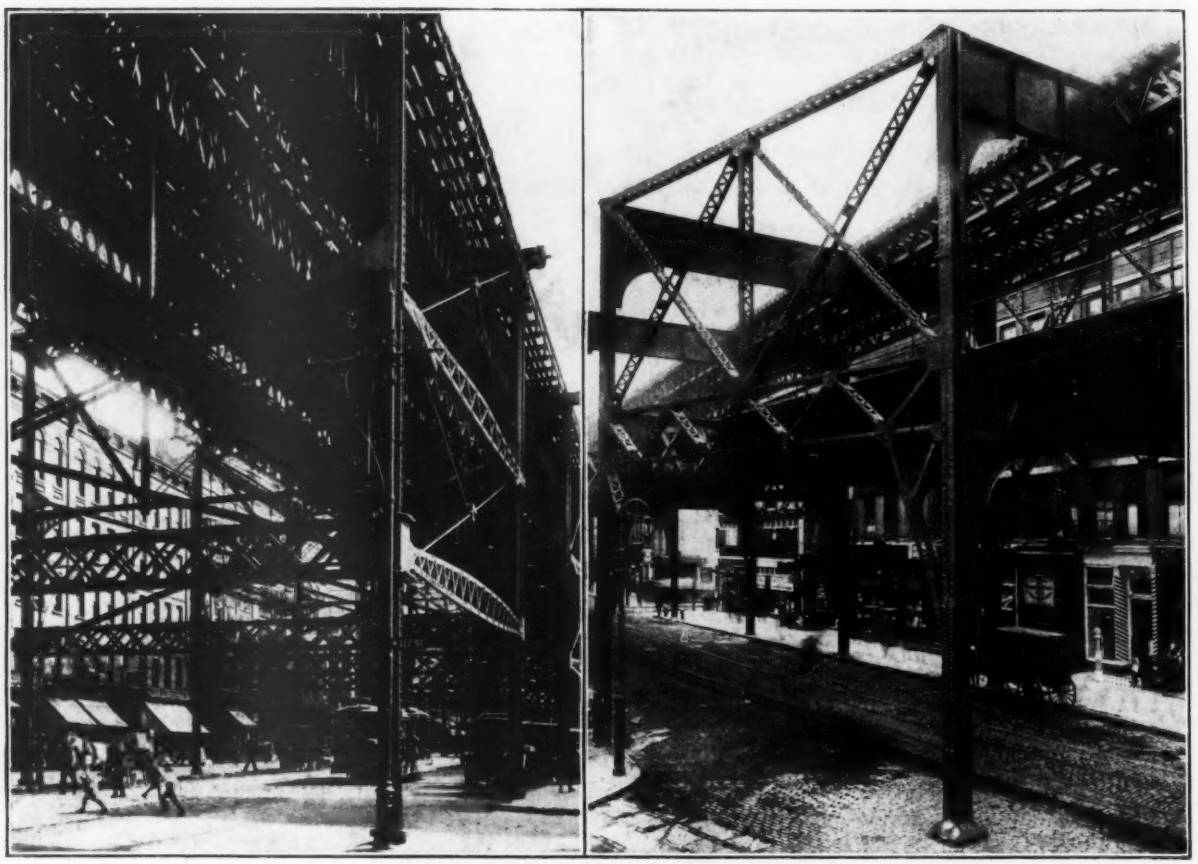
An ingenious special arrangement of station platforms was used in rebuilding the 116th St. station of the Ninth Ave. line. Here also only one island platform could be placed between tracks, but there were no outside platforms and no possibility of placing them. An island platform was therefore arranged between the southbound track and the express track, here shifted close over toward the northbound track; just north of this platform the express track was swung over to a position alongside the southbound track, and beyond this point a second island platform built

between the express and northbound track. The mezzanine station communicates with both platforms and connects them.

Shoring the Structure for Rebuilding

The simple hoisting and setting of new center track girders is carried on entirely from above by a derrick traveler sliding on the finished track and with sufficient reach to erect the span ahead and (in cases where there is an upper-deck structure) the next succeeding bent, and of sufficient capacity to lift from the street or from a construction car on one of the running tracks and set to place in the span ahead one of the new track stringers. However, as there is such a large amount of work involving changes in or replacement of old structure, the general condition is that shoring from the street surface is required as a preliminary to the center-track work.

Difficulties in the way of shoring are the presence of double-track street-car lines in all the streets on which elevated structure exists, and the fact that the clearance height of the old structure is so low that the depth available for needling girders is quite limited. The type of shoring most commonly employed, illustrated by Fig. 5 (Third Ave. near 42nd St.), comprises square towers made up of four 12x12's set in a 5-ft. square, adapted to be set directly on the street pavement and form a seat for blocking and jacks about 3 ft. below the bottoms of the track girders. At each column where shoring support is required two such towers are used, one being set just forward and the other just back of the column, directly under the outer pair of track girders, and so as to clear the street-car tracks. With towers thus placed at two columns of the bent, blocking placed on the four tower-supports the four girder-span ends and enables the track girders to be jacked up, the cross-girders to be removed and replaced, and the columns to be renewed. Where towers could not be placed to give direct support, or where a center track also had to be supported, transverse I-beams bearing on a pair of towers were placed under the track girders.



FIGS. 8 AND 9. SPECIAL BRACING OF RECONSTRUCTED ELEVATED-RAILWAY STRUCTURES IN MANHATTAN

Fig. 8—Additional bracing of high structure on the Ninth Ave. line at Eighth Ave. and 117th St. On both transverse and longitudinal bracing of the towers, the lower panel has been added. Note gusset-plate connections to Phœnix columns. Fig. 9—Tower bracing of double-deck structure on Park Row

Removing and Resetting Cross-Girders

At some locations the cross-girders after being cut loose from their connecting track-girders can be slipped out endways and removed, all interfering stiffeners being cut away to make this possible. In many cases, however, the cross-girder has to be cut into three pieces—cutting loose the center section and lowering it into the street, and then slipping out the two end sections. The cutting is in nearly all cases done by oxyacetylene burners.

Erection of the new cross-girders is done either by slipping in the two ends from the sides and lifting up the center section from the street and splicing, or by lifting the girder up straight in one piece, its top flange being left off to be put in place after the girder is set.

(*Concluded in next week's issue*)

Water-Typhoid Suit Lost

A suit to recover $15,000 damage for a death from typhoid fever alleged to have been caused by polluted water due to a faulty check valve between a mill supply and the supply furnished by the Circleville Water-Supply Co., of Circleville, Ohio, was decided in favor of the company early last May. Although the decision was in a petty court and can in no sense be regarded as laying down the law in Ohio or elsewhere, the alleged facts in the case and some of the instructions given to the jury by the presiding judge seem worthy of record.[1] The following notes have been taken from a summary of the testimony prepared by Barton Walters, of Circleville, Ohio, counsel for the water company.

According to the testimony, there was only one death from typhoid fever in Circleville during the 3¾ yr. ending with September, 1913. Changing now from deaths to cases, the testimony indicated one case in October, one in November, two in December, 1913, 14 in January, 1914, 20 in February of the same year, and after that scattering cases which brought up the total to 54 cases. There were five deaths. An investigation of 43 cases by the Ohio State Board of Health showed that these were distributed among 40 families containing 178 persons; two cases were probably due to contact, and one case was contracted outside of the city. There seemed to be no connection between the outbreak and the milk supply, the State Board of Health concluded. It appeared that 70% of the families affected used unsanitary privies [it should be noted, however, that the outbreak was in the winter], but the company's water-supply was in general use, and while wells and cisterns were common, water from these was not used for drinking purposes.

The husband of the deceased brought suit for damages, alleging that it was the duty of the Circleville Water-Supply Co. to furnish pure and wholesome water, and that the company had disregarded this duty, negligently permitted the water-supply to become contaminated and thus caused the death of his wife. The alleged cause of this pollution was not the regular supply of the Circleville Water-Supply Co., but water from the Scioto River, which, it was claimed, gained access to the mains of the water company through an emergency connection between the fire-protection water-supply system of a large paper mill of Circleville and an emergency connection between this supply main and the water main of the Circleville Water-Supply Co. According to the summary of the testimony prepared by Mr. Walters:

> This connection was made between the sprinkler system of the mill and the mains of the Circleville Water-Supply Co. by installing an 8-in. Pratt & Cady check valve with an automatic swinging gage. This valve was installed, it was claimed, eight or ten years ago, and was so arranged that the water could pass from the mains of the public utility to the mains of the industrial plants whenever the pressure in the industrial plant was lower than that in the city mains.

The defendant company tested the valve from time to time by means of a water meter set in a rubber-hose bypass, relying upon the meter to show water passing in either direction after closing the manually operated gage set at the connection. Quoting again from Mr. Walters' summary of the testimony:

> It was claimed that in January, 1914, this test as described was made and that it was discovered that a considerable quantity of water from the mains of the paper mill was passing back through the check valve into the mains of the water company. A trench was opened in the street and the valve uncovered, and upon removing the bonnet it was found that the wing or swinging gate of the valve was worn and it dropped down far enough to allow it to "cock," that it was off its seat and in such a position as to allow a quantity of water to pass from the paper mill into the mains of the water company whenever the paper mill's pressure was greater than the water company's pressure, which occurred frequently, and the plaintiff claimed that it was in this manner that the water-supply became polluted. It was pointed out that all of the cases of typhoid, with but two or three exceptions, occurred in a section of the town embracing six or eight blocks adjacent to the American Strawboard Co.'s paper mill.

Mr. Walters' summary of the testimony did not disclose any denial by the company that the check valve leaked at the time of this test, but the water company introduced evidence to show that for a year previous it had tested the valve at least once a month and had always found it in proper working order.

Evidence was introduced (by which side is not stated in the summary sent by Mr. Walters) showing that Circleville is located on the Scioto River 30 mi. below the outfall of the Columbus sewage-treatment plant and "tending to show the presence of B. coli in large numbers in the water of the Scioto River at Columbus and also at Circleville," the latter in the vicinity of the strawboard mill in January, 1914. Evidence was also introduced that claimed to show that "for some time prior to the outbreak of typhoid the water in a portion of the mains of the water company was milky and evil smelling."

The defense of the company as summarized by Mr. Walters was as follows:

> The defendant denied that it had furnished impure water and denied that the plaintiff's intestate contracted typhoid fever by drinking water supplied by the defendant; denied that it had been negligent in any particular, and set up the defense of contributory negligence and contended that inasmuch as the citizens of Circleville had been cautioned and advised by the newspapers of the city almost daily to boil the water for safety, and the fact that it was notoriously well known and discussed by the citizens of the city that the public water might be polluted and might be the source for the numerous cases of typhoid, that the drinking of the unboiled water by the said Iva Grant, deceased, was such negligence upon her part as would preclude recovery by her administrator for her death.

The judge issued a long series of instructions to the jury which may be summed up as follows: The defendant company could not be held as a guarantor or insurer that the water furnished by it to its consumers did not contain pollution; the company could only be held "to exercise ordinary care in the operation of its plant," including a workmanlike installation of a standard check valve in the mill connection and ordinary care in testing the check valve; the company could not be held liable for an accident to the check valve. The judge declared further:

> Although you find that the defendant failed to exercise ordinary care in the operation of its plant, and that on account thereof said Iva Grant contracted typhoid fever from water supplied by the defendant and died as a result, I charge you that if you further find that Iva Grant had knowledge or reasonable means of knowledge that said water was polluted before and at the time she drank the same, then she took upon herself the risk of drinking such water and you must return a verdict in favor of the defendant.

The judge declared that "reasonable knowledge" that the water was polluted would be afforded by proof of warnings to that effect published in the newspapers and by open discussion of the alleged water pollution by neighbors and their caution to one another to boil the water.

[1] The case was brought by Samuel C. Grant, administrator of the estate of Iva Grant, deceased, in a petition to the Court of Common Pleas of Pickaway County, Ohio, dated May 28, 1914. The decision was rendered by the jury on May 4 or 5, 1915.

The defense in the case was made by Barton Walters, of Circleville, Ohio, the attorney already mentioned, assisted by William Miller, an attorney of Columbus, Ohio, and by George A. Johnson, of New York City, and A. Elliott Kimberly, of Columbus, Ohio, sanitary engineers. The general supervision of the case was directed by A. W. Cuddeback, superintendent and engineer of the Passaic Water Co., of Paterson, N. J., in behalf of the Circleville Water-Supply Co.

Pier and Pile Foundations on Earth and Rock

Work on the Circle Building, a new and in some respects remarkable structure, is rapidly nearing completion. The building is located on an irregularly shaped plot on the north side of Columbus Circle, New York City. It fronts 261 ft. on Central Park West, 316 ft. on Broadway, 195 ft. on 61st St., and 38 ft. on the Circle end. The first floor of the building contains stores and display rooms, the second floor being devoted to office purposes. The original layout contemplated a five-story structure with a tower extending 25 stories above the roof. This plan is being held in abeyance and the building has been carried up only two stories. The idea of constructing a high tower, however, is still alive and the footings and columns in the central portion of the building were designed and constructed to take ultimately the load of such a tower.

Rock at the site varied considerably as to depth. Fortunately the low height of the building made it unnecessary to sink the piers to rock, except those designed to carry the proposed tower. These piers were in all cases sunk to rock by open excavation, rock being struck at a maximum depth of about 18 ft. At one point south of the center of the plot, along Broadway, rock showed about 6 in. below curb. The elevation of the grillage beams was 4 ft. below the cellar floor.

Where possible, the piers were excavated with buckets operated by A-frame bull-wheel derricks, but the smaller

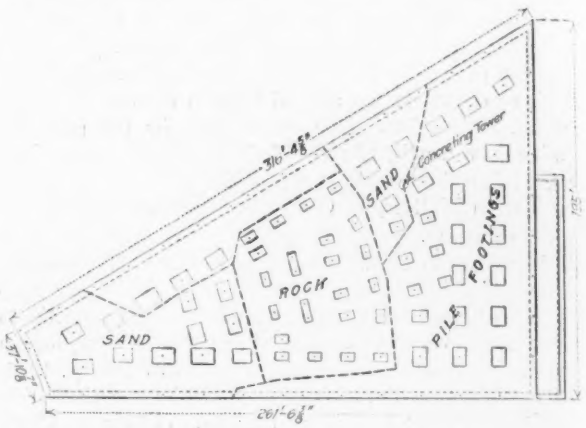


FIG. 2. FOUNDATION PLAN OF CIRCLE BUILDING

piers had to be dug by hand. Those of medium size were dug out in stages (benched out). In the smallest holes pails were filled with earth and hoisted out by hand. The pier pits were sheetpiled with tongued-and-grooved yellow-pine piles 16 to 20 ft. in length. At the deep piers followers were used in driving the sheeting.

Fig. 2 is a foundation plan. The piers for the two-story part of the building rest on sand or on blue clay, and most of them have direct soil footings. At one corner several piers have Raymond concrete pile foundations. These consist of two to six piles per pier and a reinforced-concrete cap plate 3 ft. thick.

FIG. 1. GENERAL VIEW OF WORK ON CIRCLE BUILDING, SHOWING CHUTING SYSTEM IN OPERATION

FIG. 3. VIEW OF THE CIRCLE BUILDING SITE TAKEN TWO MONTHS AFTER FIG. 1
Grillage beams on piers in foreground. Recesses left in wall at right for later placing of columns

The cellar was excavated by a steam shovel, which started at one end of the site and worked in to the other end, where it turned around and dug its way out. The spoil was loaded on 3-ton motor trucks, which were loaded with 4 yd. Twenty trucks were employed, each hauling seven loads per day. The trucks were drawn out of the excavation by a cable operated by a hoisting engine.

Difficulties from Ground Water

A spring in the north end of the excavation caused very mucky soil in the vicinity. The water had to be pumped out of the pier excavation continuously. Double-diaphragm gasoline pumps were used in some cases, but these were only satisfactory on lifts of from 18 to 20 ft. For the most part high-pressure steam pumps were employed to jet out the water. Steam pressure as high as 110 lb. was used. Water from pier excavations was pumped into a receiving tank to allow the sand in suspension to settle. A pipe led from the tank to the sewer, though the sewers in the vicinity of Columbus Circle are very small for the duty they have to perform.

Puddled-Concrete Building Wall

A part of the building wall is carried on 238 concrete piles driven 2 to 2½ ft. c. to c., the spacing of the piles being less at column locations. The average penetration was 12 ft. It was necessary to proceed with the concreting before the steelwork was received. The grillage beams were secured and placed before the walls were poured, recesses being left in the walls at column locations to provide for the future placing of the wall columns. When the columns were received they were erected and forms placed in front of them and the recesses filled with concrete. Some of these recesses are visible at the right in Fig. 3.

The wheelbarrow method of distributing concrete from mixer to the required location was tried and quickly abandoned as being excessively costly. A 75-ft. tower[1] was then erected at the point indicated in Fig. 2 and the concrete chuted from a point 65 ft. above ground to all parts of the wall. The chuting run varied up to 200 ft. At the forms two men hoed the concrete, which was of soupy consistency, from the chutes into the forms and puddled the concrete thoroughly with scrapers similar to those used to remove ice from sidewalks.

An interesting point in connection with the excavation developed after the foundations had been built. It was determined that the boiler room was not as high as it should be. The column footings at this location were therefore underpinned and the floor of the boiler room was lowered 7 ft. by hand excavation. The soil was mucky,

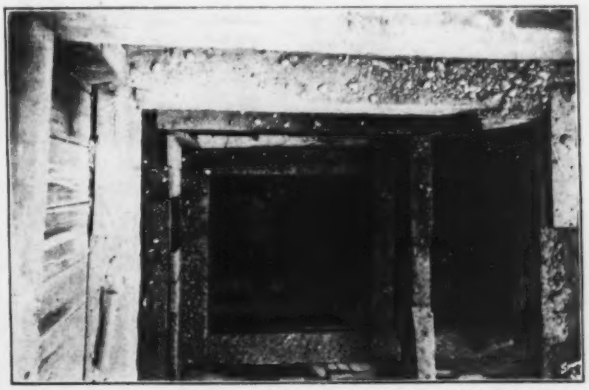


FIG. 4. TIMBERED DEEP-PIER EXCAVATIONS
Looking down into Nos. 57 and 58 of Fig. 1

so that it was necessary to keep gasoline pumps operating while work was in progress.

The general contractor is the Columbus Circle Construction Corporation, of which H. Mandel is president. The superintendent of construction for the contractor is F. L. Shea. R. E. Moss is engineer and James C. Green, architect. The building is owned by the Hearst interests.

[1] F. L. Shea, Superintendent of Construction for the Columbus Circle Construction Corporation, described the concreting plant used on this job in "Engineering News" of Sept. 2, 1915.

Development of Ultra-Violet Water Disinfection

SYNOPSIS—The adaptation of the ultra-violet water-treatment method to American conditions is outlined and some installations are described.

The gradual technical development of the use of ultra-violet light in sterilizing water has been variously noted in *Engineering News*[1]. During the past two years an American concern, the R. U. V. Co., of New York City, has been developing the ultra-violet process for American conditions. Some of the results secured are here given.

The theory of the ultra-violet process may be briefly summarized: Ultra-violet rays are given out in profusion by the electric arc between metal electrodes and especially by the mercury arc. But where glass walls inclose the arc stream, as in the case of the ordinary mercury lamp, the walls absorb a large part of the ultra-violet light. By putting the mercury arc in a quartz tube and working it at high intensity, the absorption is prevented and a possible source of intense radiations is provided.

The bactericidal effect of ultra-violet light is well known. The ordinary pathogenic organisms are easily and quickly disintegrated under its influence, but as the ultra-violet rays have no great penetrating power for opaque objects, it is advisable to remove the suspended matter from the water by filtration and then to run the water in thin streams past the source of light. To guard against the effect of microscopic suspended matter, a single passage of the water is not relied on, baffles and tortuous passages being arranged to give several exposures of a given quantity of water, which has been thoroughly stirred up.

[1]The sterilization of water by ultra-violet rays was noted in the following articles: "Sterilization of Polluted Water by Ultra-Violet Rays," Sept. 15, 1910; "Sterilization of Polluted Water by Ultra-Violet Rays at Marseilles, France," Dec. 8, 1910, and Dec. 7, 1911; "Water Purification by Ozone, Ultra-Violet Rays, and Chlorine," Aug. 24, 1911, Oct. 17 and Dec. 19, 1912; "The Application of Ultra-Violet Rays for Purifying Large Quantities of Water," Aug. 21, 1913.

Early Work and American Conditions

The early work was done with water not under pressure or in a closed system. The most of the potable American water-supplies that might be treated by ultra-violet rays, where electricity can be supplied and good supervision secured, require that the process be carried on while the water is passing through a pressure system. Therefore only the principles of the process as worked out abroad are of particular service in this country; quite new apparatus has had to be developed. The cases where the water being treated flows in open channels are the small supplies in which the water is drawn off slowly into storage bottles, etc., or circulating systems for swimming pools.

Of some 320 plants installed or approaching completion in this country, 20 are for swimming pools, about 200 are of the small gravity-flow units of 60 to 120 gal. per hr. capacity, and about 100 are of the larger pressure-type sterilizers of 200 to 3000 gal. capacity. The first cost is about $750 per 1,000 gal. per hr. capacity for the larger machines, rising to about $900 for the smallest.

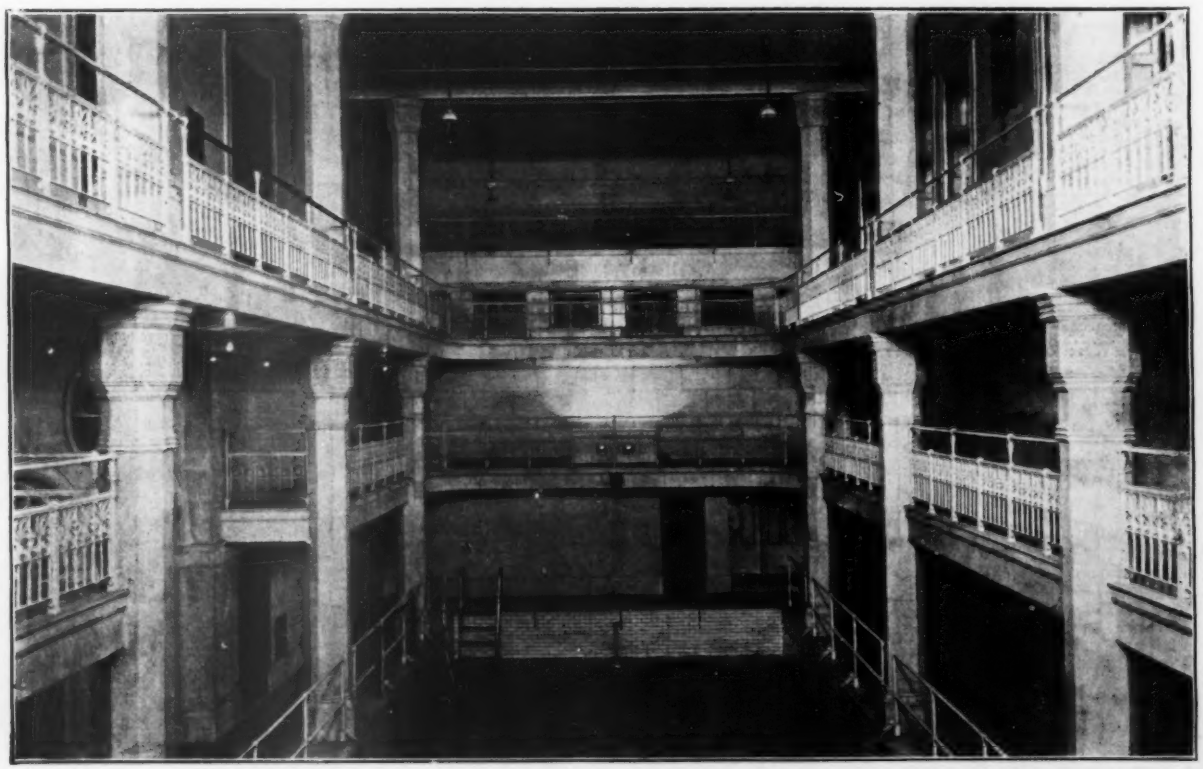


FIG. 1. SWIMMING POOL AND ULTRA-VIOLET RAY STERILIZER, NEW YORK ATHLETIC CLUB

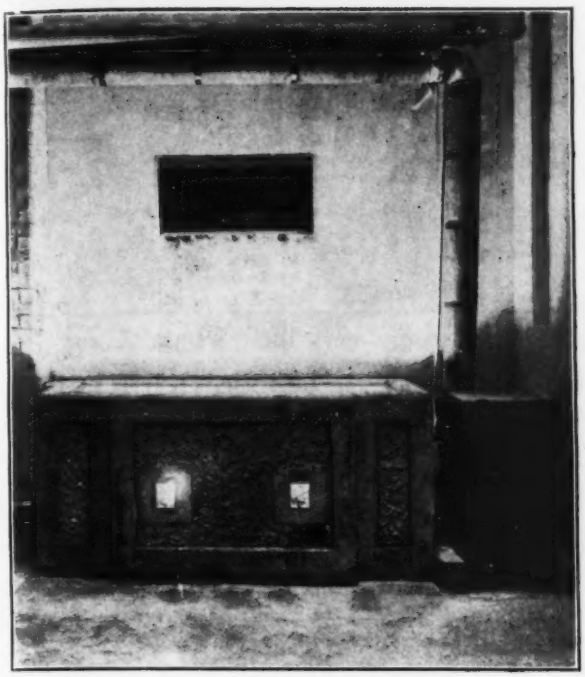


FIG. 2. STERILIZING TANK AT WEST SIDE Y. M. C. A., NEW YORK CITY

Direct current is required for the lamps in all cases. For the smallest machines the supply is at 110 volts, for the larger ones it is at 220 volts, while the largest require 500. Where direct-current at proper voltage is not available, rectifiers or motor-generator sets are used.

Disinfection Tanks for Swimming Pools

When ultra-violet light is used in purifying the contents of swimming tanks, the water is circulated, filtered and sterilized. It is led off, as usual, by the drain at the lowest point of the swimming tank, and forced by a small motor-driven centrifugal pump through filters to the sterilizer tank, which is usually elevated so that the water may run through and discharge by gravity. Fig. 1 shows such an installation at the New York Athletic Club and Fig. 2 that at the West Side Y. M. C. A. in New York City.[2] In each of these places two mercury-arc lamps are used, the sterilizing tanks being provided with baffles so that the water passes repeatedly under the rays.

Tests of the water at the New York Athletic Club showed a count of 280 bacteria per c.c. (agar plates at 40° C. for 24 hr.) in a sample taken over the drain pipe, with B. coli present in 75% of the 1-c.c. inoculations. The count at tank outlet was 2 per c.c., with no B. coli in 10-c.c. inoculations. At the West Side Y. M. C. A. the count before installation of the ultra-violet sterilizer was 2,200 to 5,100 per c.c., with B. coli present. This quickly dropped to 400 to 600, with no B. coli; and eventually ran from 10 to 70 in the pool, with no B. coli found.

Further development of the swimming-pool sterilizer is being made to evolve a standardized line that can be installed without the special work now often involved.

[2]Besides the two swimming-pool installations shown in Figs. 1 and 2, notable examples of these sterilizers are to be found at such places as the West Side Y. W. C. A. in New York, the Germantown Y. W. C. A., the Detroit and Dayton Y. M. C. A. buildings, the Minneapolis Athletic Club, the Forest Home School in Milwaukee, and the Forest Park Highlands, St. Louis, Mo., the last for a large open-air pool.

The design of sterilizer shown in Figs. 3, 4 and 5 has been developed for treating water under pressure. The water flows in a circuitous path through an iron casing in the center of which is packed a quartz tube whose interior is open to the air for the insertion of the mercury-arc lamp. The flow is divided, and on each side the baffles are arranged so that the water passes back and forth radially, coming close to the lamp twice. These types are made in two sizes—one for 600 to 1,000 gal. per hr. and the other for 1,000 to 3,000 gal. The smaller one requires 0.55 kw. power and the larger 1.25 kw. The lamps used are shown in Fig. 5. The only labor required is the tilting of these lamps to start and an occasional cleaning of the casing.

Where the water to be treated is not perfectly clear, the supply has to be prefiltered, the type usually employed being a vertical pressure cylinder packed with sand, charcoal or bone black—depending on the quality of the raw water. The loss of head through the filters is from 6 to 12 ft., while that through the sterilizer is 2½ ft. for one size and 3 ft. for the other. Where the pressure head of the supply system is not large enough to pass the water through the sterilizers and deliver properly, booster pumps are employed. Where it is desired to treat supplies greater than the capacity of a single unit, two or more are used in parallel; it is not unusual to install a duplicate sterilizer as a spare unit for use in contingencies.

Automatic lamp control for large sterilizers and full electric control of water flow are being developed. When these are perfected the entire sterilization process can be controlled from the switchboard.

Out of the earlier design of small gravity-flow sterilizer first furnished, the automatic type shown in Fig. 7 has been developed. Water flows into an enameled iron tank

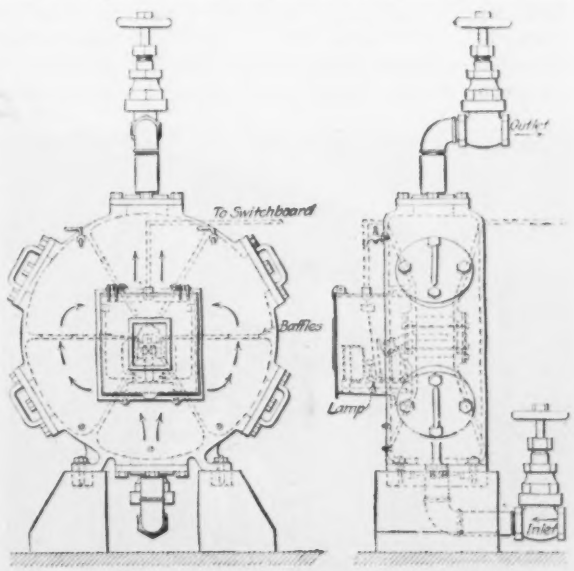


FIG. 3. PRESSURE TYPE OF STERILIZER

and around baffles so that it passes twice in thin streams close under the lamp. The lamp frame is fastened to the plunger of a solenoid through which the main current flows; closing the lamp circuit then lifts the lamp and starts the arc, while breaking the current causes the mercury tube to lower ready for starting again. Where the total daily consumption is small but there are occa-

sional heavy drafts of water, this sterilizer has been used, overflowing into a storage tank.

A small pressure sterilizer (200 gal. per hr.) has been built along the lines of the apparatus shown in Figs. 3, 4 and 5. A different type of lamp is used, however, such that automatic tipping of the lamp, as previously noted, is obtained.

Many Carbon-Free Metals and Alloys Now Available

In many metallurgical operations there is need of employing carbon-free metals and alloys in order to control fully the physical properties of the final metal, which may be a special steel or bronze, for instance. A large number of these have been developed by the Goldschmidt Thermit Co., of New York City, employing in their production the well-known aluminum-oxidation reactions by which a high temperature is produced in carbon-free surroundings. A brief review of the uses of most of these is given, from notes by H. De Courcy Browne, metallurgical engineer of the Thermit Co., in the paragraphs which follow. The approximate analyses are appended in a group.

Pure Manganese Products

Manganese, 97-98% pure, has been a commercial product for over 10 years. Its melting point is about 1260° C. It dissolves very readily and alloys can be easily made with chromium, aluminum, copper, zinc, tin, nickel, titanium, etc. It is not detrimental to some work where the usual 80% ferro-manganese with its combination of iron and carbon has been dropped. It is used in the manufacture of cupro-nickel, german-silver and aluminum sheets, where it has been found that a small addition increases the ductility in rolling. It is also used in the manufacture of manganese bronze and is especially advantageous where a high manganese and a low carbon content is desired. Manganese is generally added in the ratio of about ¼ to ½%, although in some resistance metals the content goes as high as 10%. This metal in powdered form is used by steel foundries to obtain a hardened surface on certain parts of steel castings; the "flour" is mixed with a binding material and swabbed on the mold where it is desired to harden the casting.

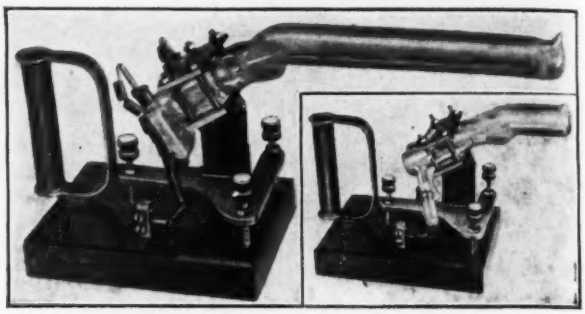


FIG. 5. PISTOL-TYPE MERCURY-ARC LAMPS

Chromium, Cobalt, Copper and Nickel

Pure chromium (98 to 99%) is generally used in resistance metals and mixtures where a high chromium content is desired; for example, in fine tool steels, projectiles, etc. The general addition of pure chromium is about ½ to 4%. In resistance metals the content often goes to 15% and even 30%.

Cobalt, made in 97% purity, has aroused great interest in the steel business since 1913. It is used in ordinary high-speed tool steel, where it is believed that the addition of about 5% improves the cutting qualities. The possible use of cobalt in brasses and bronzes is being studied.

Cobalt-copper: A small addition of cobalt, from 0.10 to 0.25%, increases the physical strength of brass and bronze castings and drawn wire, and of manganese-bronze, low brass and "88-10-2" or gun metal. In this nonferrous work, a 10% cobalt-copper alloy can be used to advantage.

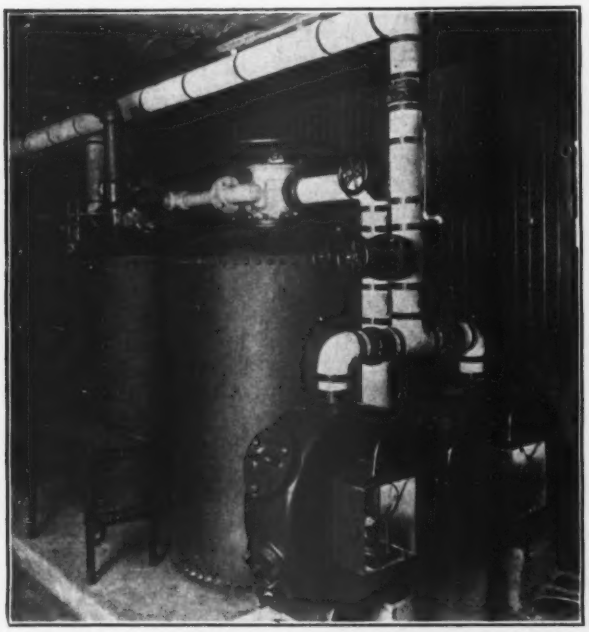


FIG. 4. STERILIZER INSTALLATIONS AT MARSHALL FIELD STORE, CHICAGO

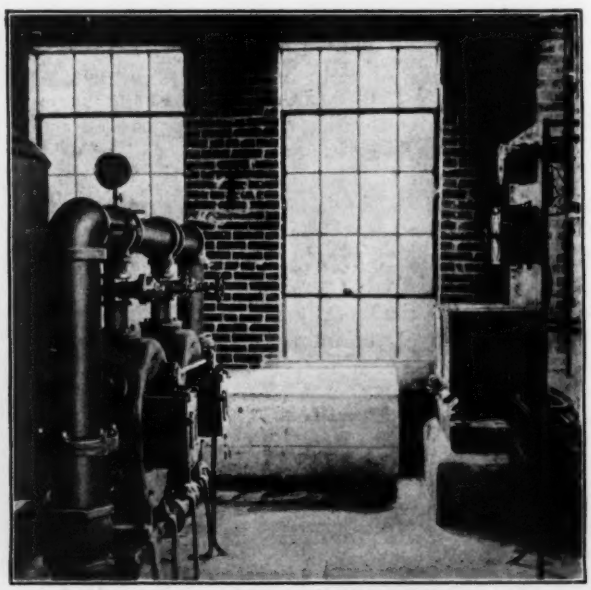


FIG. 6. INSTALLATION OF VALLEY PARK (MO.) WATER CO.

A 50-50 nickel-copper alloy is one of the new combinations. It is used in german-silver castings and where a small percentage of nickel is desired in bronzes of high physical strength. This alloy dissolves at a much lower temperature than pure nickel so that it is not necessary to raise the temperature of the treated metal above normal. Nickel is also thus introduced in a plastic lead or bearing alloy to prevent segregation of the lead. In all so-called red-metal alloys where nickel

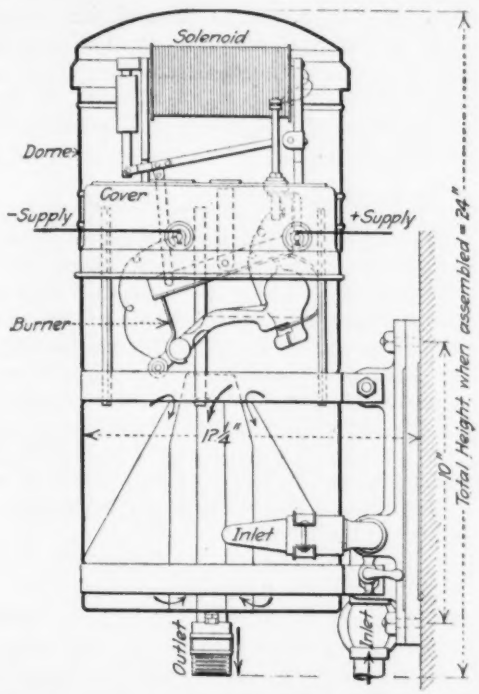


FIG. 7. ARRANGEMENT OF SMALL AUTOMATIC ULTRA-VIOLET STERILIZER

is introduced to promote fineness of grain and increase of tensile strength this combination is economical.

Carbon-Free Ferro-Alloys

Ferro-titanium, 25%, is used with both iron and steel; a small addition, generally about 1¼ lb. of the alloy per ton of metal treated, tends to cleanse the metal thoroughly, the titanium having an affinity for oxygen and nitrogen. With carbon-free alloy no carbides are formed and all the titanium is available to the steel or iron, resulting in an exceptionally dense and close-grained metal.

Ferro-chromium, 60%, has a very wide commercial use and many steel makers prefer it to the low-carbon electric-furnace product. The general addition of ferro-chromium would be about the same as for pure chromium.

Ferro-vanadium, either 25 or 40%, is used in practically all grades of tool steel, where it has been found that vanadium has a tendency to intensify the hardening and toughening effects of other alloys. Vanadium is also used in steel castings that are subjected to high static and dynamic loads. Probably in from 50 to 75% of the locomotive frames the metal is treated with about ¼% of vanadium. In locomotive cylinders it has been found that vanadium will close the grain of the iron and produce better castings. In steels for automobile parts, such as gears, axles, crankshafts, etc., this alloy is widely employed. The usual addition of vanadium is about 1%. For high-speed and crucible tool steels, for automobile steel and steel castings it is generally about ¼%. With cast iron the addition is usually about $\frac{1}{10}$%.

Ferro-boron, so far, has had only a very narrow commercial field, although lately considerable study has been given to the use of boron in various steels in the hope of ascertaining the field for this element.

Ferro-chrome-cobalt is used in chromium-cobalt steels and some melters prefer it to using cobalt and chromium metals separately. The addition of this alloy is the same as cobalt.

Carbon-Free Manganese Alloys

Manganese-titanium is generally used in high-class bronzes, where it has the advantage of the strong combination of manganese and titanium. It is a very stringent deoxidizer and will also increase the physical strength considerably. The addition of alloy is generally about ¼ to ¾%.

Manganese-boron is used for the same general work as the manganese-titanium alloy just mentioned, although boron is used considerably for high-conductivity copper castings. It is used under the same general conditions and in the same ratio approximately as manganese-titanium.

Chromium-manganese is advantageous for certain classes of work where otherwise chromium would have to be used separately. It dissolves at a considerably lower temperature.

Manganese-aluminum, 25 to 75%, is a new development. This is made from the 98% pure manganese and is technically free from iron and carbon, both of which are extremely detrimental in aluminum work. This alloy dissolves at a low temperature, and its usual effect on aluminum castings is to reduce shrinkage, close the grain and increase density. Considerable improvement in strength, without appreciable loss in ductility, can be obtained.

ANALYSES OF CARBON-FREE METALS AND ALLOYS (EXPRESSED IN PER CENTS)

	Pure Manganese	Cobalt-Copper	Pure Cobalt	Pure Chromium	Chromium-Manganese	Manganese-Boron Balance	Manganese-Titanium Balance	Ferro-Chrome Cobalt	Ferro-Boron	Ferro-Vanadium	Ferro-Chromium	Ferro-Titanium
Manganese	97.–98.	Trace			70	60.0–62.0	54.0–55.0				0.25–0.50	0.25–0.50
Aluminum	0.25–0.50	0.10–0.25	0.25–0.50	0.25–0.50	0.10–0.25	1.0–1.5	5.0–6.0	0.25–0.50	1.00–1.50	0.25–0.75	0.50–	1.0 or 6.0
Silicon	0.50–0.75	Trace	0.25–0.50	0.10–0.25	0.25–0.50	0.5–1.0	3.0–4.0	0.50–0.75	0.25–0.50	0.25–0.75	0.50–0.75	0.50–0.75
Iron	0.50–1.00	Trace	1.00–2.00	0.25–0.50	0.25–0.50	0.5–1.0	1.0–1.5	20.0	Balance 75.0–78.0	Balance 75.0 or 60.0	Balance 40.0	Balance 70.0
Phosphorus	0.10–0.25	Trace	Trace	Trace	Trace					Trace	Trace	Trace
Sulphur	Trace	Trace	Trace	Trace	Trace					Trace	Trace	Trace
Cobalt		10.0	97.0					40.0				
Copper		89.0										
Chromium				98.0–99.0	30.0			40.0			60.0–61.0	
Boron						35.0			20.0–25.0			25.0
Titanium							35.0					
Vanadium										25.0 or 40.0		
Arsenic			None									
Nickel			1.00									

City Planning in Queens Borough, New York--I

By Frank B. Tucker*

SYNOPSIS—A description of the methods employed in converting the largest and most rural of New York City's five boroughs into a real city; showing how a comprehensive city plan is being worked out so far as possible within legal limitations and complications.

The Borough of Queens, New York City, with an area of 117.4 sq.mi., is the largest of the city's five boroughs. It is part of Long Island and extends from the East River and Long Island Sound on the west and north to the Atlantic Ocean on the south.

Previous to its inclusion within the corporate limits of the City of New York (1898) the Borough of Queens, then a part of the County of Queens, comprehended Long Island City, the towns of Flushing, Jamaica and Newtown and part of Hempstead; eight incorporated villages—College Point, Flushing, Whitestone, Jamaica, Richmond Hill, Rockaway Beach, Arverne and Far Rockaway; and numerous unincorporated communities.

At the time of the consolidation, only one existing map, that of Long Island City, containing 4741 acres, was officially accepted; of the remaining 70,370 acres, there were no official surveys or maps. The work of making these surveys was begun under the old Board of Public Improvements of the city, in accordance with the general plan of making complete topographic surveys of all the boroughs.

Until 1903 the topographic survey work in Queens was almost wholly of a preliminary character. The triangulation on which the survey of the Borough of the Bronx is based was extended to Queens, and numerous triangulation and traverse stations were established there. A net of levels was also run, establishing benchmarks. The work of these years proved of inestimable value when the work was taken up in Queens as a problem separate and distinct from the other boroughs, following the abolishment of the Board of Public Improvements (1902), when topographical survey bureaus were established in all the boroughs.

Work of the Topographical Bureau

Following the establishment of the Queens Topographical Bureau, a comprehensive line of work was determined upon: (1) A topographic survey; (2) a tentative street system design based upon the topographic survey; (3) a detail property survey of existing streets and their demarkation upon the ground with monuments as well as the demarkation of new streets; (4) a final map laying down the lines of all streets, their widths and grades, and the linear and angular dimensions of all blocks as determined by the detail property survey and by computations.

The Bronx triangulation system has for its axes of coördinates, Tenth Ave., Borough of Manhattan, and 225th St., Borough of the Bronx. The Tenth Ave. axis is 28° 59′ 13.5″ east of true north; the 225th St. axis is, of course, normal to this. These axes were retained by the Topographical Bureau, and to them all its coördinates still refer. Eventually, however, they will be transformed to the triangulation system of Greater New York, established for the city in 1908 by an officer of the United States Coast and Geodetic Survey (see *Engineering News*, May 21, 1903, page 456).

Topographic Survey Methods

The nucleus of control for the topographic survey was the traverse and level net that the old Board of Public Improvements had spread over the borough. Most of the traversing was done with 50- and 100-ft. tape catenaries, provided with handles for adjustment to tension and temperature. At frequent intervals the tapes in service were compared with one standardized at Washington. All measurements were made twice and required to check within 0.02 ft. in 1000 ft. Angles were turned 24 times (angle 12, explement 12, each 6 times with the telescope erect and 6 times with the telescope inverted). The closures were within $\frac{4}{1}\frac{0}{2}$ sec.

Levels were run with common wye levels and ordinary target rods, reading to 0.001 ft., with foresights and backsights equalized, 225 ft. being taken as the criterion for a proper sight. Two rods were used and each was read separately on every turning point and benchmark. The operation was then repeated with a new setup of the level in approximately the same position. The mean of all the readings was taken as final, and in a given run the allowable error was $0.02\sqrt{\text{distance in miles}}$.

Nearly all topography was taken with planetables. This work is now complete, but at its height seven planetable parties were in the field, composed of six men each. All planetable work is to a scale of 1 in. = 80 ft.; each sheet covering a strip of country 2,000 ft. wide, and of variable lengths, depending on conditions. On each sheet were first drawn the range and traverse lines in blue and green respectively; the range lines were 500 ft. apart.

In the fieldwork there were few departures from conventional methods. The purpose of this survey was to gather data necessary for the design of a street system, so accuracy and speed were the prime requisites. Accuracy in the determination of existing street lines was of paramount importance; next, buildings and contours. The latter were of 5-ft. intervals, and were run out in the field. To do this a level was used in conjunction with the planetable and two or sometimes three rodmen were employed.

As soon as a planetable sheet was completed, it was turned into the office, where it was transferred *in toto* to mounted sheets, 31x53 in., representing an area of 2,000x4,000 ft., or 183.6 acres. For many purposes a scale of 80 ft. to the inch is too great, so these sheets were pantographed down to a scale of 1 in. = 200 ft., on mounted sheets of the same size as for the other scale.

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These sheets then included an area of 5000x10,000 ft., or 1148 acres.

Tracings are made of these 200-ft. topographic sheets and prints taken; these are matched and pasted together until they comprehend a large area. This assembled print serves as a study plat, wherewith to work out the design of a street and grade system.

Design of the Borough Street System

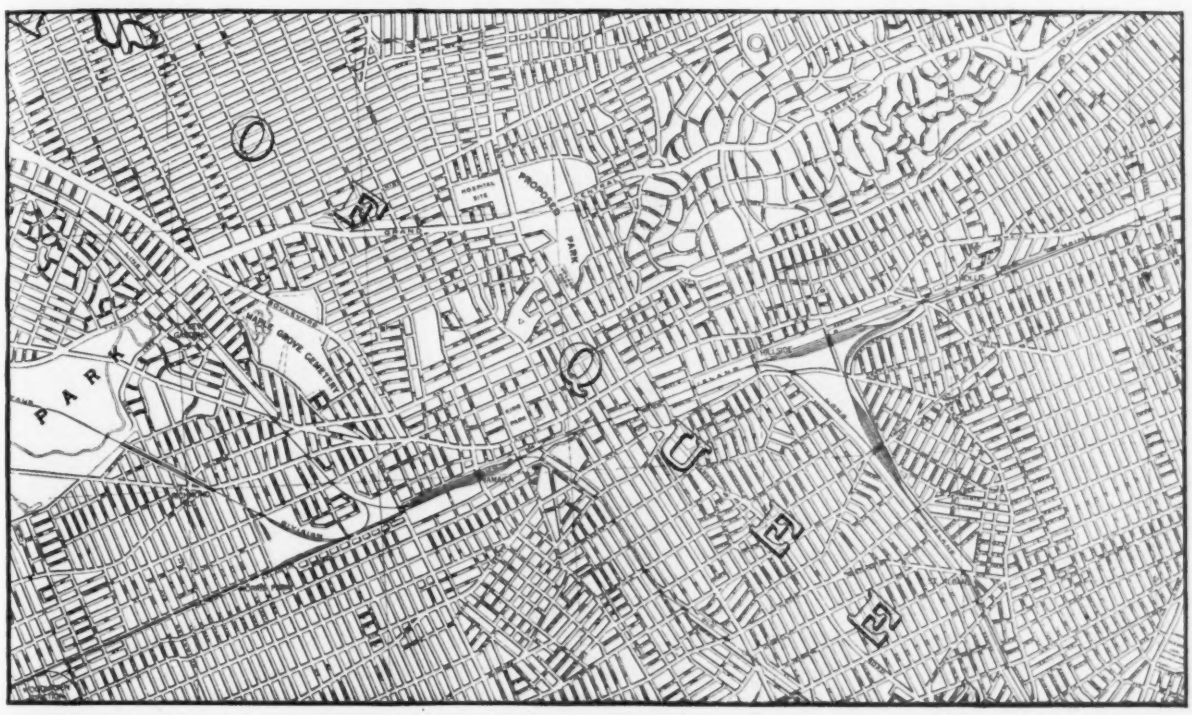
In designing the street system of Queens, the engineers of the Topographical Bureau have recognized from the first that a great influx of population would follow adequate transit connections with Manhattan and Brooklyn, and have attempted to design a street system that would weld together the multitudinous existing streets into a comprehensive and harmonious whole, in anticipation of such development. Queens has offered little leeway to apply idealistic principles of city planning.

On the assembled prints of the reduced planetable sheets careful study of the undeveloped areas is made to determine their proper street treatment, and of the developed areas to determine the streets that shall be widened and those that shall be discontinued.

For the undeveloped areas blocks 200x600 ft. are freely used, with the long dimension parallel to the trend of probable greatest traffic. This size of block gives 48 lots, 25x100 ft., or 60 lots, 20x100 ft., the lot dimensions common in New York. When conditions require blocks of other dimensions or of irregular shape, the aim is to obtain the greatest possible number of lots 100 ft. deep, for this depth of lot seems peculiarly adapted to New York's needs—a greater depth not appreciably increasing values, but a lesser depth materially decreasing them.

New York seems to have adapted itself to streets 60 ft. wide and avenues 100 ft. wide. These were the widths used when the street plan of old New York City was laid out in the first decade of the Nineteenth Century, and to these widths, especially the former, both public and private streets have been opened, although in a number of instances parsimonious real estate promoters used a lesser width.

In designing the street system for the Borough of Queens, 60 ft. and 100 ft. have been the widths commonly used, although intermediates have been freely admitted. Two marked exceptions, involving the use of greater widths, deserve special attention: Queen's Boulevard, extending from the Queensboro Bridge to Jamaica, a distance of nearly six miles, is to be the widest street in the Borough—200 ft. The city has already acquired title to the right-of-way; its physical treatment, however, due to its exceptional width, is as yet only partially determined. If present plans mature, Grand Central Parkway, 150 ft. wide, will extend from Queen's Boulevard near its Jamaica terminus, eastward (atop the "backbone" of Long Island, affording in places a view of both Long Island Sound and the Atlantic Ocean) to the boundary of the City of New York, a distance of about 7½ miles.



SECTION OF MAP OF QUEENS BOROUGH, SHOWING HOW EXISTING AND NEW STREETS ARE HARMONIZED

Adjusting Street Grades to Topography

The fixing of street grades has not been difficult from a topographic viewpoint. The topography of Queens is not rugged, and in only a few sections is it necessary to observe contours in locating streets. With new streets, drainage and a minimum of earthwork are the governing considerations.

With existing streets, difficulties are frequent, because of the economic necessity of recognizing improvements already installed. It is, of course, impossible always to hold present grades, but in most cases a careful study will reveal means whereby it may be done or at least close-

ly approximated. Crowns within the block will often accomplish the desired purpose.

In fixing grades those at curb and house lines should be officially established as well as those at center line; otherwise discrepancies will occur at these points by reason of surveyors using different methods of interpreting the center-line grades.

At the time of designing the street system, areas whose natural topography suggest their adaptability to park purposes are set aside. But the city's present policy of assessing the cost of its park purchases upon the limited area especially benefited is not propitious to the early acquisition of these lands for parks. There is nothing to prevent the owners of these areas proposed as parks by the Topographical Bureau from subdividing them into building lots or otherwise disposing of them; thereby augmenting their cost and the difficulty of their purchase when congestion of population will have made their acquisition still more desirable.

Widening the Existing Streets

The design of a practicable street system requires the widening of many existing streets and the discontinuance of others. The experience of the Topographical Bureau with such streets has not been very satisfactory. On the first designs prepared, the number of widened and discontinued streets shown was plentiful, but the accomplishment of these improvements was defeated in most cases by the property owners or by legal difficulties. The result was that for several sections the street design had to be entirely recast to incorporate some old road, or to hold existing streets to their present width.

The cost of widening a street in New York City is now a matter of local assessment; consequently property owners are bitterly opposed to all street widenings, although tacitly admitting the wisdom of such procedure. They view wide streets as a benefit to the whole community and clamor to have a large portion of the cost placed upon the city at large (a practice that obtained in past instances) or the scheme abandoned, a prerogative that a majority of those affected can exercise.

An arbitrary rule of the City Board of Estimate and Apportionment is that streets of a length greater than 1500 ft. shall be at least 60 ft. wide. This rule cannot be rigorously applied. Many streets of a lesser width, usually 50 ft., are of purely local importance and can never become important traffic streets. The widening of such streets is always protested by property owners.

In other cases, streets of lesser width have been extensively improved with buildings, and damage claims, were the streets widened, would be prohibitive; and as there is no law in New York making it obligatory for new buildings to observe widened lines, these streets must be continued at their present width.

The determination of what streets shall be widened, and whether the widening shall be on both sides or only one, are matters that require a thorough investigation in each instance. Where no buildings are affected it is usually best to divide the widening equally between both sides, otherwise the lots on the widened side may be so materially shortened as to seriously impair their value. Where buildings have to be moved or removed economy will generally require that the widening be all on one side, except in the widening and straightening of old roads, where, by shifting from side to side, it is often possible to avoid buildings.

Discontinuing Existing Streets

The discontinuance of an existing street is difficult. The statute law relating to the discontinuance of streets in New York City is most comprehensive in phraseology, but is applicable to only a few streets. In brief it vests in the proper local authorities full power to discontinue all streets necessary effectually to secure and preserve regularity and uniformity in a general and permanent street system. It states that upon the filing of an official map establishing a permanent street system for a section the streets shown thereon are the only lawful streets, and that the fee owner of a street not shown thereon may inclose, use and occupy the area as fully as if it had never been a street, if not then in use, or if in use, upon the day a permanent street is physically opened to take its place.

Seen from an engineer's viewpoint the leeway allowed by this law for the discontinuance of a street at variance with a proper street plan is all that could be desired; but from a legal viewpoint it is beset with many difficulties. Its weakness lies in its failure to provide a practicable disposition of the street upon its discontinuance. And what is true of this law is true probably of any law that can be evolved for the case.

Who Is the Fee Owner of a Street?

It is all very well to say that the fee owner may inclose, use and occupy the area as if it had never been a street; but who is the fee owner?

The reversion of a street upon its discontinuance to the fee owner thereof as provided by this law is possible and equitable only when the fee-ownership of the abutting property upon both sides is in the same person, or in persons in full sympathy and accord with one another, which is seldom the case.

To determine the fee ownership of a street is often impossible because the fee is lost either in the incompleteness or in the total absence of an official chronicle of its succession from the patents of Holland and England. To the streets that date from the Dutch occupation of New Amsterdam (New York) the fee title is acknowledged to be in the city. But to the streets that date to the sovereignty of England, the city claims only an easement title. In the case of streets that date from American Independence no generality is possible, fee or easement titles being acquired according to the idiosyncracy of each community or to individual whim if privately opened and tendered to the authorities.

Establishing Identity of Streets

To discontinue any street other than one whose fee is in the abutting owner is quite impossible—in the case of the old Dutch streets, because of the absence of all data conclusively establishing their identity and defining them by bearings, distances and widths; with the English streets there is the same absence of dimensions. Their identity, however, is possible as there is extant an excellent map of New York and Staten Island and a portion of Long Island, made in 1781 by General Sir Henry Clinton, Commander-in-Chief of His Majesty's Forces, then occupying New York. By eliminating from this map the few streets of possible Dutch origin, we have left those opened during the English colonial days.

From the close of the Revolution to about the end of the first half of the Nineteenth Century, street records are very meager and unsatisfactory. With the exception of the regularly incorporated turnpikes, proof of streets originating during this period is arrived at more by a process of elimination than by recorded evidence, land being of too small value to warrant any elaborate street opening procedure.

Beginning with about the latter half of the Nineteenth Century, land values began to rise rapidly, and where streets were opened by the authorities, the statutory legal requirements were observed. Consequently surveys and descriptions of a more or less satisfactory nature are matters of record for these streets, where the records have not been lost. Besides the streets regularly opened by the authorities, most of those privately opened by real-estate promoters, through the subdivision of acreage into building lots, also date from this period. The filed plots of these subdivisions in the county clerk's office are very complete, and the dimensions they give are dependable.

The discontinuance of any of these streets would of course work hardship to the abutting owners, though in the case of streets originally private there is no implied obligation on the part of the authorities as to their permanency; but there is on the part of the persons who privately opened them. While the city may officially discontinue a street, its fee owner cannot take physical possession of it, because he has parted with an easement in it to every person to whom he has sold property fronting upon it.

Some Guiding Principles

It must always be borne in mind that the cost of any change in the grade, width or alignment of an existing street will be a tax upon the community, usually levied directly upon property owners in the immediate vicinity; perhaps very poor people struggling to own a home and already heavily burdened with mortgages and general taxes. Unless of obvious necessity or palpable advantage the width and grades of existing streets should be held, for against the opposition of affected property owners the accomplishment of changes is impossible.

The exception to this statement is the old arterial highways. Their continuance as urban streets at their existing widths and grades is quite out of the question, and their discontinuance is precluded by the almost certain confusion of their fee title; so they must be developed and utilized to the best advantage. This will usually be found to be their continuance as arterial thoroughfares, for as originally laid out, they probably represent the line of least resistance between the several communities which they serve.

The experience of the Topographical Bureau has shown that the best mode of treating these old highways is to widen them, improving their alignment and grades, and use them as axes from which to extend rectangular street systems. In their widening, however, care must be taken to include the lines of the old highway entirely within those of the new, for otherwise there will be left a strip of the old street between the new and the abutting private property, the fee title to which may be impossible of adjudication.

A second article will describe the engineering work done in establishing the predetermined city plan, of which the accompanying illustration is typical.

Costs of 12- and 16-Ft. Lengths of Cast-Iron Pipe Laid

By F. C. Roberts*

When the manufacture of 16-ft. lengths of cast-iron pipe was undertaken by the American Cast Iron Pipe Co., of Birmingham, Ala., a year or more ago, it was apparently regarded by other manufacturers of this commodity as a more or less hazardous business innovation, and by users of cast-iron pipe as somewhat of an experiment. Both classes seem to have been unaware of the fact that the manufacture of 16-ft. lengths of cast-iron pipe has long since been successfully practiced on the Continent of Europe.

In the hope of stimulating argument on a subject that is of importance to users of cast-iron pipe, I subjoin the following cost figures, of laying both 12- and 16-ft. lengths of pipe. The figures given are complete as to all details of the work, except overhead charges (interest, depreciation of tools, superintendence, etc.). It should be remembered that all costs fluctate with the wages and efficiency of skilled and unskilled labor, the character of the work demanded, and other local conditions.

The wage scale was $4 for skilled labor, $3 for unskilled, and $5.50 for teams, all working 8 hr. per day. Lead cost $0.0445 and hemp cost $0.05 per lb. The trenches were 20 in. wide and had depths of 28 in. for the 4-in., and 30 in. for the 6-in. pipe, and bell holes at intervals of 12 and 16 ft., according to which length of pipe was being used. The soil was a sandy loam. Shoring was not required, and there was no macadam or pavement. The backfilling was done with a scraper and the water tamping and crowning by hand labor.

Table 1 gives general comparative data for the pipe alone, and Table 2 gives field costs for the pipe in place. The figures are for unbroken runs of pipe; that is, specials, hydrants and valves have been omitted, since these vary with almost every job.

TABLE 1. GENERAL DATA FOR 4- AND 6-IN. CAST-IRON PIPE IN 12- AND 16-FT. LENGTHS

Diam., In.	Length, Ft.	Approx. Weight per Length, Lb.	Total Lengths, Ft.	Total Weight, Tons	Cost of Pipe, F.o.b. Shop	Cost of Pipe, F.o.b. Destination
4	12	260	40,000	434.0	$20.40	$33.40
4	16	340	40,000	425.0	21.40	34.40
6	12	400	4,000	66.6	18.40	31.40
6	16	520	4,000	65.0	19.40	32.40

TABLE 2. FIELD COSTS PER FOOT OF LAID PIPE

	4 in. x 12 ft.	4 in. x 16 ft.	6 in. x 12 ft.	6 in. x 16 ft.
F.o.b. destination..	$0.3623	$0.3655	$0.5228	$0.5265
Distribution	.0054	.0053	.0083	.0081
Trenching	.0576	.0576	.0600	.0600
Laying and cutting	.0120	.0112	.0184	.0171
Yarn and lead....	.0316	.0237	.0431	.0324
Fuel	.0033	.0024	.0046	.0035
Yarning and leading	.0045	.0037	.0067	.0050
Bell holes.....	.0166	.0125	.0208	.0156
Calking*	.0062	.0046	.0091	.0070
Testing†	.0051	.0048	.0059	.0054
Backfilling‡	.0216	.0215	.0225	.0223
Totals	$0.5262	$0.5128	$0.7222	$0.7029

*All calking was done by hand. †Testing includes touching up or repouring defective joints. ‡Backfilling includes tamping.

COMPARATIVE SUMMARY OF COSTS

Diam., In.	Total Length, Ft.	Pipe Length, Ft.	Cost per Ft.	Total Cost
4	40,000	12	$0.5261	$21,048
4	40,000	16	.5128	20,512
Difference			$0.0133	$536
6	4,000	12	$0.7222	$2,888
6	4,000	16	.7029	2,811
Difference			$0.0193	$77

*Consulting Engineer, Marsh-Strong Bldg., Los Angeles, Calif.

Kansas City Maintains Open Asphalt Specifications

By Clark R. Mandigo*

SYNOPSIS—With the experience gained in building and maintaining 4,000,000 sq.yd. of asphalt pavement, the engineers of Kansas City, Mo., have developed specifications and tests for asphaltic cement which are simple and easily understood, and which are truly open specifications, in that they pass all asphaltic cements which service shows makes satisfactory pavements.

Within the past ten years a large number of asphaltic cements, including various natural bitumens, the blown oils and manufactured asphalts have been placed on the market. Municipal engineers have been confronted with the problem of selecting the good and discarding the bad. When the almost infinite variety of mixtures, fluxes and degrees of refinement are considered, the difficulty of making a proper selection is apparent.

Within recent years considerable progress has been made toward standardizing asphalt tests, but although the majority of cities use a so-called "open" specification, there is little agreement except on a few of the older tests. This condition is caused largely by those who sell asphalt. Unlike cement and brick manufacturers, who have been untiring in their efforts to standardize tests for their materials, the asphalt interests have been constantly fighting for advantage over one another.

The asphalt companies are responsible for the ten-year maintenance guarantee; they have argued that so long as they were to keep the pavement in repair for ten years the quality of the materials to be used should be left to them. Where intelligent supervision and care were exercised by the contractor, the early asphalt pavements, as a rule, were satisfactory, for they were all built on the results of experience with one kind of asphalt. When it became necessary or desirable to use other kinds of asphalt, it was found the former criteria did not always hold.

Kansas City Experience

Kansas City, Mo., has maintained open specifications on asphaltic cement for the past ten years. The original specifications as written by Dr. Walter M. Cross, city chemist, are quoted in full in the appendix of the 1908 edition of Richardson's "The Modern Asphalt Pavement." It will be noted that no requirements are imposed on the contractor as to the kind of "raw" asphalt or flux used, but that certain tests are prescribed for the asphaltic cement used in the paving mixture, and that any asphalt passing these tests may be used, provided it shall have been successfully used in the paving industry under similar conditions for four years prior to the letting of the contract.

This idea of dealing only with the finished product and fixing requirements for the asphaltic cement as it enters the wearing surface mixture has since been successfully maintained in the Kansas City specifications. With the addition of the ductility and viscosity tests, about 8 and 6 yr. ago respectively, the requirement as to prior use of the material was dropped and asphaltic cement is now accepted for paving purposes on the basis of a series of laboratory tests only.

*Assistant City Engineer, Kansas City, Mo.

Kansas City Specifications

The present specifications read as follows:

Asphaltic Cement—The asphaltic cement used in the wearing surface, when considered apart from the mineral matter which it may contain, shall have the following characteristics:

It shall be free from water or decomposition products.

The various hydrocarbons composing it shall be present in homogeneous solution, none of oily or granular character being present.

It must be of such consistency that at a temperature of 25 deg. C. a No. 2 needle, weighted with 100 grams, will not in 5 sec. penetrate more than 9 nor less than 4½ mm. The exact penetration shall not vary more than 0.4 mm. from that fixed by the city engineer within the limits specified. The No. 2 needle referred to is a common sewing needle about 1 mm. in diameter and tapering uniformly to a sharp point for 1 cm. of its length.

Twenty grams of it shall not lose more than 3 per cent. in weight upon being maintained at a uniform temperature of 165 deg. C. for 5 hr. in a cylindrical vessel 3 in. in diameter and 1 in. high.

Twenty grams of it shall not lose more than 6 per cent. in weight upon being maintained at a uniform temperature of 205 deg. C. for 5 hr. in a cylindrical vessel 3 in. in diameter and 1 in. high.

It shall be soluble in chemically pure carbon bisulphide (CS_2) at air temperature to the extent of at least 95 per cent.

It shall not contain more than 4½ per cent. of carbonaceous matter insoluble in chemically pure carbon bisulphide, at air temperature.

It shall be soluble in 85 deg. Bé. petroleum naphtha, air temperature, to the extent of not less than 65 per cent. and not more than 72½ per cent.

Its solubility in carbon tetrachloride shall not be more than 1½ per cent. less than its solubility in carbon bisulphide—both tests being made at air temperature.

It shall show of fixed carbon not more than 15 per cent.

It shall show a flashing point (New York State closed oil tester) of more than 175 deg. C.

Its viscosity at a temperature of 0 deg. C. shall not be less than 0.15 grams. Viscosity of asphaltic cement by the terms of this contract shall mean the number of grams of asphaltic cement that will, in 4 hr., be forced through a circular orifice 1.0 cm. in diameter by a pressure equal to that exerted by a column of mercury 150 cm. high. The asphaltic cement during this test shall be contained in an iron cylinder 42 mm. in diameter and 100 mm. high, and the thickness of the plate through which the orifice is made shall not be more than 2.0 mm.

Its ductility at a temperature of 25 deg. C. shall be not less than 15 cm. [The minimum until recently was 10 cm.] Ductility, by the terms of this contract, shall be understood to mean the distance in centimeters that a cylinder of the asphaltic cement, 1 cm. in diameter, can be drawn out at the rate of 1 cm. per min. The drawing out shall be accomplished by means of two similar cups cylindrical in form, of inside diameter of about 3 cm., open at one end and having a concentric orifice 1 cm. in diameter through a circular plate not more than 0.5 mm. thick, which covers the other end. To make a determination, one of the cups is placed on a smooth surface with the open end down. The other cup is then placed on top of the first, with the open end up, so that the 1-cm. orifices coincide. The hot asphaltic cement is poured into the top cup slowly, so as to fill both cups completely. The temperature of the asphaltic cement is then cooled to the temperature of 25 deg. C., and the cups are pulled apart at the rate of 1 c.m. per min.

The asphaltic cement used under this contract must not be changed as to the brand, kinds, proportions and qualities of the ingredients during the progress of the work.

All of the tests except the ductility and viscosity tests are familiar to paving engineers and chemists, are performed in accordance with the best practice of standard laboratories and require no further explanation.

Methods and Apparatus Described

The apparatus for making the ductility test is of an inexpensive design developed by Dr. Cross and has some rather striking features. Two brass cylindrical cups about 3 cm. in diameter and 6 cm. deep have a hole 1 cm. in diameter bored through the center of the bottom of each and reamed out at a wide angle from the inside so that the thickness of the plate bottom at the edge of the hole is ½ mm.

In making the test the open end of one cup is fitted over a short rubber cylinder which is embedded in a lead weight, the other cup is placed on top of the first so that the orifices exactly coincide and the two cups are filled by pouring the melted asphalt into the upper cup. After the asphalt has cooled, the cups are placed in water kept at a temperature of 25 deg. C. until the asphalt has adjusted itself to this temperature. The cups are then placed in the bottom of a glass jar filled with water at a temperature of 25 deg. C., the lead weight being used as a base.

Above the jar, on a rack, is set a metronome, such as musicians use, but from which the bottom has been removed, and which has been so adjusted that it will wind a wire on the wheel next to the spring drum at the rate of 1 cm. a min. A fine, flexible wire is attached to the upper cup, and the metronome is placed over the glass cylinder so that the pull will be vertical as tested by a plumb-bob. The metronome is started and the cups are pulled apart at the rate of 1 cm. per min. As soon as the fine thread of asphalt is seen to break and wave in the water, the metronome is stopped and the distance between faces of clips is measured.

A metronome with a strong spring should be selected, and even then it is sometimes necessary to help it along at first to get the cups started apart. The cups are carefully machined and polished so as to set tight against each other. The jar used is a heavy glass cylinder about 3 in. (4½ in. would be better) in diameter and 36 in. long placed in a round can. The bottom is sealed by pouring asphalt in the space between the can and the glass.

Advantages of the Ductility Test

The commendable thing about this test is the uniformity of results. It measures the elongation of a cylinder of asphalt 1 cm. in diameter and 1 mm. long and eliminates, as far as possible, all variable factors which might affect the results. Duplicate tests made on the same asphalt or by different observers check very closely. Although pulled at a slower rate, the elongation obtained by the Cross method is only about one-half to one-third of that obtained by the briquette method, but there is no fixed ratio between the two. The minimum limit set by the specifications is therefore more severe than that usually required. The ductility test is of course the determination of the adhesiveness of the asphaltic cement, and this is now recognized as important.

The viscosity test as first used was performed at a temperature of 25 deg. C., but on account of the difficulty in maintaining this temperature for a long period, and because it did not give all the information desired, the

FIG. 1. APPARATUS FOR ASPHALT-DUCTILITY TEST

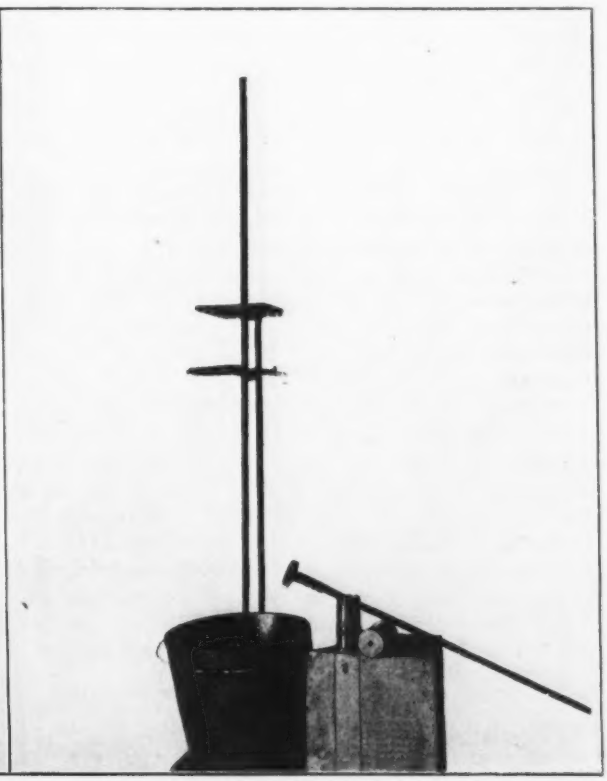


FIG. 2. APPARATUS FOR VISCOSITY TEST

0 deg. C. test was substituted. Zero temperature is easily maintained in the laboratory with melting ice.

Apparatus for the Viscosity Tests

The apparatus for this test is very simple and inexpensive. An iron cylinder of the size specified, threaded at both ends, has two threaded caps, one of which is 2 mm. in thickness with a 1 cm. hole drilled in the center; the other has a welded shank threaded for a ⅜-in. gas pipe about 145 cm. long. A glass tube is cemented into the top of the gas pipe and marked at a point 150 cm. above the bottom of the cap. In making the test the lower cap is screwed on, placed on a smooth surface and the cylinder filled full with asphalt; after this has cooled the upper cap is screwed on, the pipe is attached, and the whole is suspended in a pail of crushed ice by clamps on the iron pipe. The pipe and glass tube are then filled with mercury to the 150-cm. mark, and after about one-half hour such asphaltic cement as has been forced through the orifice is shaved off and the beginning time noted. At the end of four hours the cylinder is removed and the asphalt again shaved off, and the shavings weighed.

This viscosity test is a unique requirement for asphaltic cement and was invented by Dr. Cross to prevent cracked pavements. It has been found that asphaltic cement should have some flow even at low temperatures, so that it would adjust itself to contraction in order to avoid cracking of the asphaltic surface in winter. Since the adoption of the test no cracking has occurred where the asphaltic cement of the specified mixture showed the required zero viscosity. Most of the payments laid before the viscosity test was required did not crack, but many of them did without apparent cause.

The viscosity test makes possible the selection of an asphaltic cement which will not be in any way responsible for cracked asphaltic surfaces. It is in effect the means of testing the ductility or flow of asphaltic cement at low temperatures. A pavement built with an asphaltic cement which has some ductility at low temperatures will take up contraction by a stretching of the asphaltic film around each sand grain and will not become a brittle mass. The method of determining the viscosity, being a simple orifice test, is a true measure of the flow.

Efficiency of Ductility and Viscosity Tests

Most of the standard brands of asphaltic cement can be made to pass all requirements, except those for ductility and viscosity, with proper care in their preparation and with the use of a proper flux, although for protection against inferior grades the solubility and volatility requirements are more complete than customary. The majority of failures of asphalt submitted have been on the ductility test. The ductility test is usually made first on account of the shorter time consumed.

Of the asphalts submitted which pass all other requirements, including ductility, a number fail in the viscosity test. Some of the manufactured asphalts have been brought up to the requirements of both tests by the addition of varying percentages of natural bitumens having the properties they lack to a high degree. The fact of the matter is that no properly prepared high-grade asphaltic cement, whether natural or manufactured, which has proved itself suitable by long time usage in pavements has failed to pass the requirements. In other words, the specifications have admitted all cements which experience and good judgment show make good pavements.

The specifications have, however, passed some asphaltic cements which have been viewed with suspicion on account of their newness or origin; and while these are probably not so good as the best, they have been very satisfactory, and no failures because of the asphaltic cement have occurred in pavements laid. The specifications as outlined are made to fit the requirements of the Kansas City climate and are used for sheet asphalt and fine-graded asphaltic concrete. Where asphalt is desired for bituminous macadam, surface dressing or filler for blocks, these requirements are varied to suit conditions.

Kansas City has more than 4,000,000 sq.yd. of asphalt pavement in use on streets, exclusive of car tracks, some of which is 26 yr. old. This pavement is in all conditions, from good to bad, and has been laid under all sorts of traffic, in all sorts of manners and with a great variety of materials. Experience with these pavements forms a fair basis for present and future guidance. It has been the constant endeavor to improve the finished pavement to meet the increased severity of use, and the asphaltic cement requirements, together with mixtures and method of laying, have been modified from time to time with the idea of getting the best material and workmanship.

The testing methods outlined in the foregoing notes have proved very satisfactory over a long period of time and will undoubtedly be retained. They are presented for the consideration and discussion of those who are interested in obtaining some uniformity and certainty in testing asphaltic cement.

Municipal Research Work*

The question of research work in connection with the activities of a city is one which must be considered very carefully. Taking the country as a whole, the cities have undertaken, relatively speaking, no research work up to date. In view of the tremendous opportunity for such work and in face of the fact that at our universities and research institutions great fortunes are being spent, the isolated pieces of work carried on in our municipalities are almost negligible. My own feeling is that a part of the work now done by our cities could more properly be done elsewhere. At the present time our colleges and research institutions are the places for so-called "pure science." The net result of work of this kind carried on under existing municipal conditions is apt to be too small to warrant its being undertaken. The atmosphere in which the work of the average municipal laboratory is carried on is not especially encouraging to those types of work where results may be delayed or very definite results perhaps not even assured. On the other hand, there are varieties of work which can best be done by the cities in connection with construction.

Some day there will perhaps be instituted a generously endowed foundation for municipal research through which it may be possible to coördinate efforts of this kind in a number of different places. When this step is taken a new day will have dawned for American municipalities. Graft, inefficiency and political interference will disappear in proportion as we are able to establish definite scientific and engineering standards covering different municipal activities.

*From 1914 report of M. L. Cooke, Director of Public Works, Philadelphia.

Placing Masonry for the Elephant Butte Dam, New Mexico*

By E. H. Baldwin†

SYNOPSIS—Details of masonry work on a very large concrete dam. Masonry is rubble concrete, with smooth concrete face. Quarrying methods and grouting of cutoff wall described. (Mixing and placing of concrete and records of placing masonry will be described in a subsequent article.)

The Elephant Butte Dam is being constructed by the United States Reclamation Service across the Rio Grande at a point about 12 mi. west of Engle, N. M. It is of cyclopean concrete, will be 1200 ft. long, over 300 ft. high, and will contain in excess of 600,000 cu.yd. of masonry. It will impound 2,626,700 acre-feet of water and form a lake 40 mi. long with surface area of 40,080 acres.

The excavation for the dam was sufficiently advanced on June 3, 1913, to permit of commencing masonry work on that date, but as there was still a large amount of excavation to be done, only one cable was used on the masonry for some time.

The character of the foundation was such that it was deemed advisable to cover it with masonry as soon after exposure as possible; this was due to the stratification of the bedrock, which presented a sound and otherwise excellent appearance when first uncovered, but the great extremes of temperature in this climate would gradually open up seams that were at first imperceptible. For this reason it was considered expedient to carry on masonry operations coincident with the excavation. Whenever an area was prepared sufficiently large to make such work economical it was quickly covered with masonry. Other reasons for carrying on masonry work before the entire bottom was prepared were as follows:

A large amount of the material being excavated was sand and gravel taken from outside the neat lines of the dam. This was drawn to the outer cables by drag scrapers, picked up by grab buckets on these cables, transported to the upper railroad and carried to a storage pile for future use as concrete aggregate. This method of work rendered the middle cable useless for excavation purposes, but it was used to advantage in transporting concrete and plums to the dam and enabled a large amount of sand and gravel to be used direct from the excavation.

Using Construction Cableways for Masonry

After July 1 two shifts worked continuously on masonry, but with only one cable, until December, when one shift was transferred to excavation. In February, 1914, two shifts, but with only one cable, were used on this work, and on Mar. 1 masonry work became the main issue, with two shifts using two, and sometimes three, cables.

As will be seen in Fig. 2, a cutoff trench is excavated at the heel of the dam. This varies somewhat in section, according to the material encountered, but averages about 10 ft. wide in the bottom and 15 ft. deep below the remainder of the foundation. The bottom of this trench is in excellent sandstone, but to make sure of its solidity a number of test-holes were put down with churn drills to a depth of 25 ft. below the bottom of the trench.

*Previous articles on the Elephant Butte Dam in "Engineering News" are as follows: "Excavation for Foundation," Jan. 14, 1915; "Concrete-Mixing Plant," Aug. 6, 1914; "Construction Camp," Dec. 31, 1914.

†Assistant Chief of Construction, United States Reclamation Service, Denver, Colo.

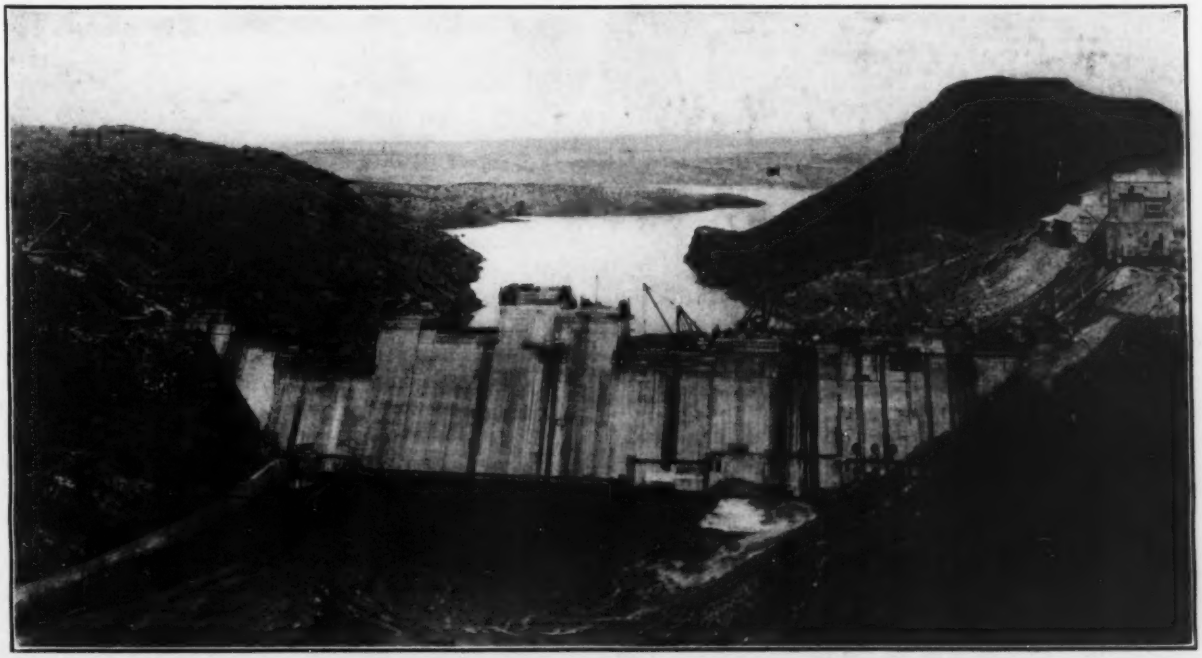
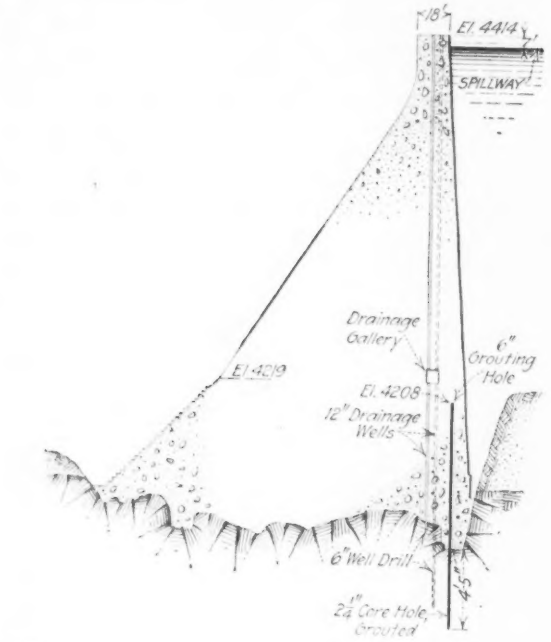


FIG. 1. ELEPHANT BUTTE DAM UNDER CONSTRUCTION

Every precaution possible was taken to prevent leakage beneath the dam or percolation through it; but in case such leakage or percolation did take place, means have been provided to lead the resulting water harmlessly away. The specifications called for a row of holes in the center of cutoff trench 10 ft. apart, parallel with the axis of the dam, to be drilled to a depth of 50 ft. below the bottom of the trench, and grouted under high pressure, to seal all accessible seams and prevent percolation under the dam. About 10 ft. downstream from the line of grouting holes a row of drainage wells, 12 in. in diameter and 8 ft. apart throughout the entire length of the axis of the dam, was provided for in the masonry to extend upward to the inspection tunnel located slightly above river bed, to discharge any water which rises to that elevation into a drainage conduit leading to the downstream face of the dam. The wells were to be drilled to a diameter of 6 in. and a depth of 45 ft. below the base of the dam. A distance of 5 ft. downstream from this line of drainage wells a similar row was provided, not extending into bedrock, but extending from the base of the dam to the inspection tunnel. These wells were staggered with reference to the wells in the upper row.

The cutoff trench was filled with 1:6 concrete, but before filling, seats were cut in the bedrock for 6-in. iron pipes, which were set up and concreted in on the location for the grouting holes. The drainage wells were carried up in similar manner, but were cast with collapsible iron forms 12 in. in diameter. When the concrete around them had set sufficiently to allow of their removal, the forms were collapsed, removed, cleaned, oiled and put back into place for further work.



Drilling the Grouting Holes

When the masonry covering was considered sufficient, or at a convenient time, the grouting holes were drilled with a Davis Calyx drill, the shot bit being used. The operation of the machine has been uniformly successful. Cores were retained from every fourth hole and stored for future reference. This machine has drilled 59 holes to a total depth of 3125 lin.ft. As the concrete was placed rapidly it frequently happened that the drill would start from 75 to 100 ft. above the hole; but this did not make any great difference, except that it caused more tubing to be handled than would otherwise have been the case. In January, 1915, a well-drill was rigged with a 3-in. string of tools and used in place of the shot drill. While this did not furnish a core, it gave just as good results and at from one-third to one-half the cost. With this drill 34 grouting holes were put down to a total depth of 1845 lin.ft. All drilling was carried on in three shifts.

The drilling of these holes was closely followed by the grouting machine. This was a No. 2 Canniff, and was operated from one to three shifts, depending on the condition of the hole or the urgency of the case. In addition to the regular grouting holes called for in the specifications, considerable other grouting was done. Wherever cracks were found in the foundation, 2-in. iron pipe was inserted and carried up until the rock was sufficiently covered with masonry to withstand the pressure, or more often until it was convenient to grout it. The grouting consisted of 83 regular holes along cutoff trench and 93 additional holes (see Fig. 3).

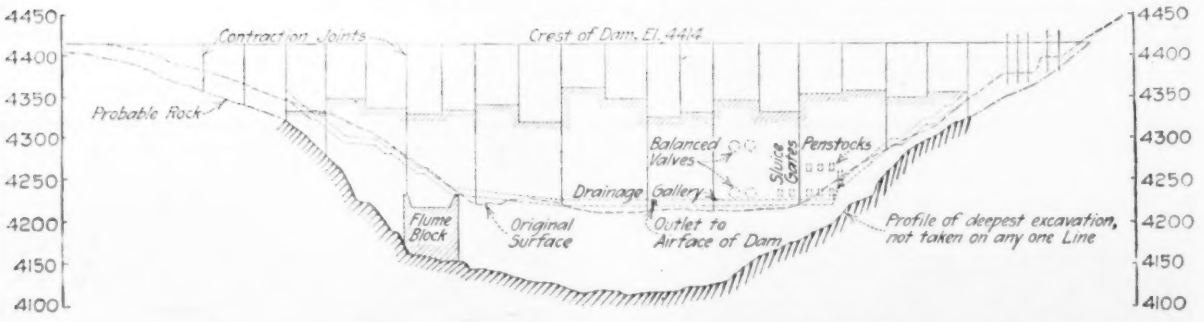


FIG. 2. ELEVATION AND SECTION OF ELEPHANT BUTTE DAM, UNITED STATES RECLAMATION SERVICE

Neat portland cement was generally used; but whenever a water test indicated that the hole was very loose and would consequently take considerable grout, sand-cement was utilized. The 176 holes so far grouted have taken 341 bbl. of portland and 1250 bbl. of sand-cement. The largest quantity of cement forced into one hole was 85 bbl. of sand-cement.

Holes were cleaned before grouting by forcing a stream of water through them. Seepage tests under gravity and pressure heads were made before and after grouting. Seepage before grouting varied from 0.1 to 150 gal. per hr. under gravity and from 3 to 192 gal. per hr. under pressure of 100 lb. per sq.in. After grouting, an average of 0.015 gal. per hr. under gravity and 1.5 gal. per hr.

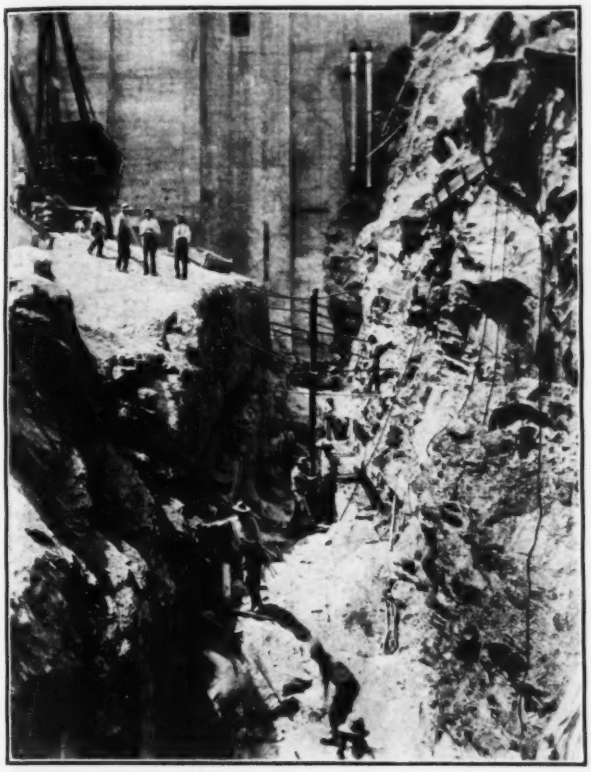


FIG. 3. PLACING GROUTING PIPES IN THE CUTOFF TRENCH AT THE HEEL OF THE DAM

under 100 lb. pressure was obtained. Three gallons per hour per 100 lb. pressure was adopted as the limit; if the seepage was in excess of this, grouting was continued until this limit was reached. Three densities of grout were used—1:7, 2:7 and 3:7 parts of cement to water, by volume. Operation was continuous with pressures from gravity to 100 lb.

Drilling Foundation-Drainage Wells

The upstream row of drainage wells was drilled with a 6-in. well-drill to a depth of about 45 ft. below the foundation. To date 165 of these holes have been drilled to a total depth of 7580 lin.ft. The purpose of this drilling was to intercept any percolation beneath the dam that might not have been cut off by the grouting, also to provide an opportunity in case percolation was considered too great, to grout this additional row of holes or as many of them as seemed necessary. As previously stated, these holes and the row 5 ft. downstream were carried up in the concrete to the floor of the inspection gallery, where any seepage water present was discharged into gutters at either side of the gallery floor and conducted to the downstream side of dam. This left a raised walk in the center of the gallery. These wells are continued from the roof of the gallery to the top of the dam, to intercept and carry off any water that enters the dam.

The effectiveness of the grouting operations has been clearly demonstrated. Careful measurements have been kept of the discharge from all drainage wells and the percolation around the abutments. On Aug. 13 this amounted to 59 gal. per min., or 0.13 cu.ft. per sec., with a head of 100 ft.

The section in Fig. 2 shows the drainage or inspection gallery and the relation of the grouting pipes and drainage wells to it. The elevation of the floor of the gallery is 4218, or about 4 ft. above the river bed, and supposed to be at all times above water level in the river below the dam. It is built the entire length of the dam, rising very slightly in grade from the low point at Station 7+30 until near the abutments, where it is carried up on a 10:8 slope.

Completed Drainage Gallery in Dam

In order to make the gallery more accessible, steps are provided on the slopes wherever steeper than 10:1. The steps are built in flights of about 25 ft. in height, with a landing; on a 10:1 slope, from 5 ft. to 10 ft. in length, according to the topography of the abutment. At one side a 1½-in. pipe handrail is provided. Conduits for electric wires were built in the concrete about 1 in. above the roof of all galleries, with openings every 20 ft. for lamps. The completed galleries and tunnels, of which there are in all about 2500 lin.ft., are well lighted and afford exceptional and convenient facilities for examining the interior of the dam and noting the percolation under and through the dam with the varying conditions of temperature and head.

It was intended to carry the drainage gallery from abutment to abutment, but near Station 9+40 the abutment was so precipitous that a vertical ladder or tunneling would have been necessary; so it was decided to end it at this point and start another about 22 ft. higher to be entered by one of the galleries provided in connection with the sluice-gate operating chambers. The drainage galleries are connected for drainage purposes by a 12-in. opening built in the concrete.

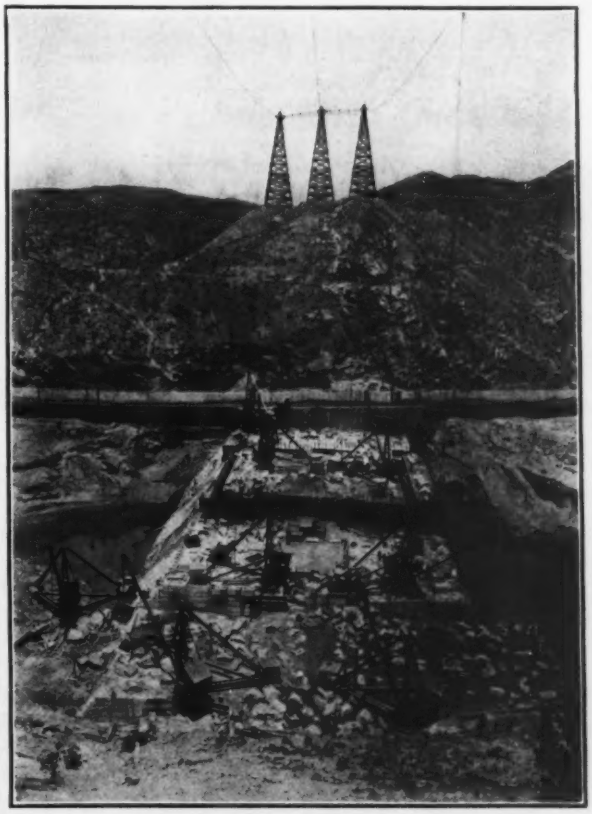


FIG. 4. FIRST STAGES OF ELEPHANT BUTTE MASONRY
Smooth surface in middle section left unroughened so that derrick pier blocks can be cast thereon

To increase the imperviousness of the upstream face special precautions are being taken. The portion of dam upstream from the upper row of drainage wells is made of a richer mix than the remainder of the dam. This is a 1:6 mix, while a 1:9 mix is generally used. There is no sharply defined line between the two grades of concrete; forms are not used to separate them, but they are blended together in a distance of from 1 to 3 ft.

Waterproofing the Upstream Face

To discourage further the entrance of water into the dam the upstream face is being coated with portland-cement mortar applied with a cement-gun. The mortar is mixed in the proportion of 1 part cement to 2 parts sand and applied in a layer about 1 in. thick. Advantage is taken of rising water in the reservoir to work from rafts specially constructed for the purpose. There are two of these, each 9x13 ft., made of planking on a framework laid on and attached to 16 oil barrels. One raft contains the machine, operator and helpers, small mixing box and a few sacks of cement and sand, while the other is loaded with cement and sand. The order of operation is to take a strip about 10 ft. high and the length of the dam at water level, and first clean it thoroughly with scrapers and wire brushes. It is then gone over with a sandblast, using coarse sand, passed through the machine to obtain the necessary pressure. This roughens the surface sufficiently to cause the mortar to adhere to it. The surface is then thoroughly moistened from a hose and immediately followed with the mortar. This is put on in four layers, each about ¼ in. in thickness. It was found that a thicker coat than this, applied on a vertical wall, without reinforcement, would, on account of its weight, slough off before setting; but by applying in thin coat this trouble was overcome. The layers follow each other before the preceding layer has attained its final set, and so far there is no indication of a parting of the layers.

Numerous samples taken from the face showed perfect adhesion to the concrete, it being impossible in every case to break mortar from the concrete at the line of contact. As indicated in the foregoing, the operation of the cement-gun is dependent on the rise of water in the reservoir; consequently its operation is somewhat intermittent. But as the small crew employed on this feature has other duties that can be worked in between, this is not objectionable, especially as it enables a great saving to be made by avoiding the necessity of scaffolding. The total area covered to date is about 96,500 sq.ft., at a cost of 8c. per sq.ft., which includes all charges.

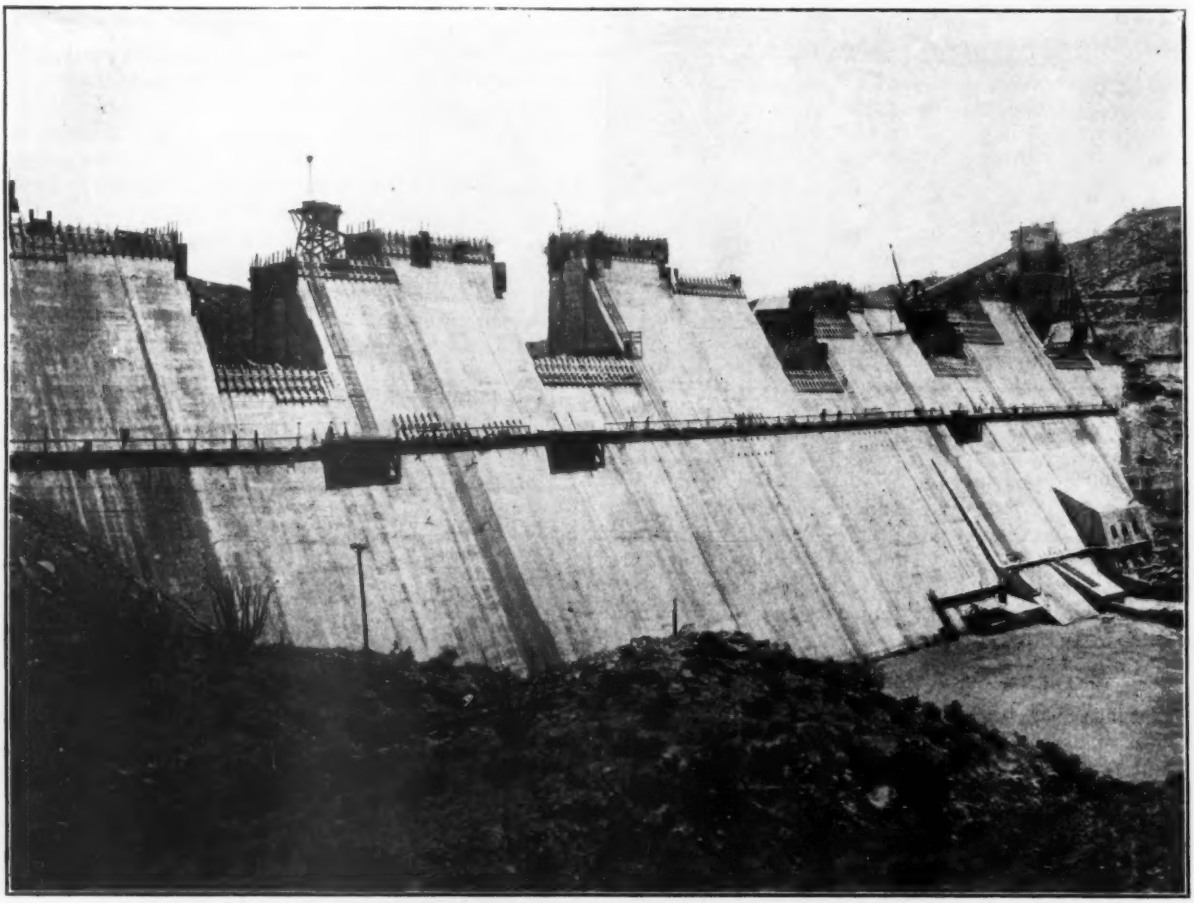


FIG. 5. DOWNSTREAM FACE OF ELEPHANT BUTTE DAM IN AUGUST, 1915

Water surface is 105 ft. above deepest part of foundation; walk is 200 ft. above foundation; completed top of dam will be 100 ft. above walk

Operation of Quarries

Three sandstone rock quarries, located from 2000 to 6000 ft. from the dam, are in use. These are known locally as No. 1, No. 2 and No. 5. First quarry 1 was

developed, but was so disappointing that No. 2 was opened up, and gave much better results. Later, in order to get more working face, No. 5 was developed, after unsatisfactory results from Nos. 3 and 4. Quarry 2 has furnished by far the greater amount of material. It contains streaks of shale, which, with the overburden of unsuitable material, gives from 15 to 20% of waste. The face as now developed is about 600 ft. long and 150 ft. high. The bulk of the rock taken from this quarry was loosened by shooting holes from 125 to 150 ft. deep, put down with a 6-in. well-drill, three or four being shot at a time. The largest single blast was in October, 1914, when four holes, loaded with 39,575 lb. of powder, were shot at once, loosening some 70,000 cu.yd. of rock.

This quarry is served by six guy derricks and a double-track standard-gage railroad. On account of the unsuitable material mixed in with the good rock, it has not been feasible to use steam shovels or other mechanical means for loading crusher rock. Rock for the crushers is broken by hand, the larger stones unsuitable for plums are plug-holed and shot and loaded into skips, which are emptied by derricks into waiting 6-cu.yd. dump cars. These are then drawn in trains of 10 or 12 cars by 16-ton locomotives to the crushers, dumped and returned for another load. Plum rock is loaded on flat cars, either in skips or chain slings, for transportation to the dam after cleaning and washing. The cleaning and washing is done on a special side track, alongside of which is a platform, built to the height of the cars, and equipped with water and air hose, pneumatic chipping tools, hammers, and numerous other tools necessary for this work. Quarries 1 and 5 are served by two derricks and one derrick respectively, and by convenient side tracks.

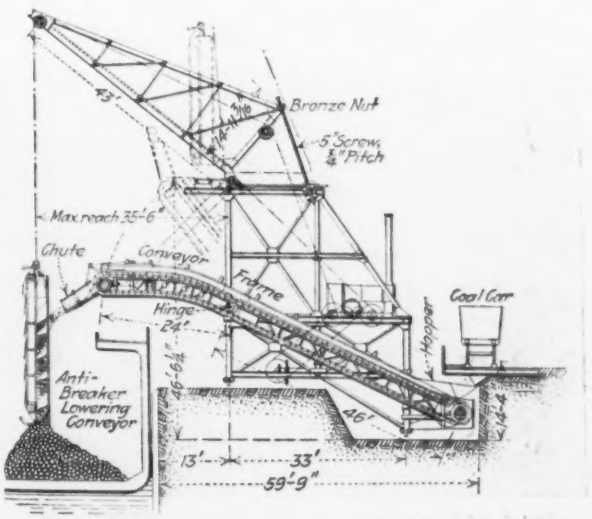
Blended-Cement Plant

With the exception of some thin reinforced work and around water outlets that will discharge under high velocity, all concrete is made with sand-cement. This is made on the work by blending the sandstone from the regular quarries with portland cement. The plant is modern and well suited to the work. It consists of rock crusher, drier, ball mill and four tube mills, with necessary conveyors, elevators and storage bins. The blend used is about 50%, but varies slightly from day to day. The product has a fineness of 90 to 93% passing the No. 200 sieve. Samples from the concrete used were at first taken daily, but are now taken semiweekly. A sufficient number are taken to provide for the following tests: 28 days, 3 months, 6 months, 1 yr. and 2 yr. A complete laboratory on the work enables these tests to be consistently carried out, and the results so far obtained from samples taken on the work bear out the previous laboratory tests that for massive work sand-cement is as satisfactory from the standpoint of strength and permanency as portland cement, and in many cases a great saving can be effected by its use. The plant has a continuous capacity of 1600 bbl. of sand-cement in a three-shift day of 24 hr.; but on account of repairs, changes, etc., from time to time it has never been run steadily on a three-shift basis. The maximum output for one month was in February, 1915, when 39,500 bbl. were produced. The operating force consists of a chemical expert, who has charge of the entire force in mill and laboratory. In the laboratory he is assisted by a chemist and a cement tester; in the mill he is represented by a general foreman, who has charge of the foremen, millers, weighers and general labor. Including the general foreman, from 7 to 10 men are required each shift.

English Ship-Coaling Machine

A coal-shipping plant installed at Workington, England, is designed specially to handle the coal with a minimum of breakage. The machine is carried by a tower traveling on a track 120 ft. long near the edge of the dock, the rails having a gage of 33 ft. In the rear of this track, and above it, is a track for the drop-bottom coal cars, the coal being discharged between the rails and delivered to a hopper on the end of a conveyor frame, which extends through the tower.

The conveyor consists of a traveling belt of steel plates 4 ft. wide, running at about 120 ft. per min. The



MACHINE FOR COALING SHIPS, WORKINGTON HARBOR

outer end of the conveyor frame is adjustable, having trunnion bearings in the front of the tower, so that it can be raised or lowered to clear deck fixtures and to give the coal as little drop as possible. The conveyor and the propelling machinery are driven from a 40-hp. engine.

A chute on the end of the conveyor frame delivers the coal to a Handcock antibreaker. This is a vertical tube suspended from a boom on the tower, and containing a series of trays attached to endless chains. The weight of the coal as it flows into the tube operates this vertical lowering conveyor. The loaded trays descend, free the coal at the bottom, and then ascend empty. An automatic brake controls the speed.

In coaling a ship, the tube is lowered till its open end is nearly on the floor of the hull, and as the coal is delivered the tube is gradually raised, keeping its end level with the top of the coal pile, so that the coal flows out without a direct drop. This machine (described in *The Engineer*, of London, July 2) is designed to deliver 400 tons of coal per hour, but can work at the rate of 600 tons per hour. It was built by F. Turnbull & Co., of Newcastle-on-Tyne, to the designs of Cecil Walton, Engineer for the Workington Harbor Board, and under the direction of Bowen Cooke, Chief Engineer of the London & Northwestern Ry.

Field and Office

Culverts Damaged by Extreme Freshet in Small Creek

By A. E. Steere*

Heavy rainfall in the Mohawk Valley and western New York State on Aug. 22, 1915, caused considerable damage to small culverts and highway bridges over small streams. One of the storm centers developed at Hoffmans; while lasting less than one hour, it caused the local streams to discharge unusual volumes of water for small watersheds. There was opportunity to get a fairly close estimate of the maximum discharge of a small stream entering the Mohawk from the north. This shows a phenomenal rate of flow per acre.

FIG. 1. CONCRETE CULVERT DAMAGED BY SETTLING OF WALLS

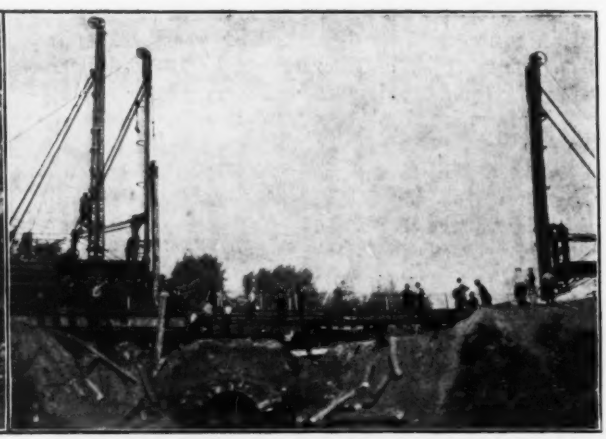


FIG. 2. OLD CULVERT PARTLY WASHED OUT WHEN FLOWING UNDER LARGE HEAD

The stream has a drainage area of about 1¼ sq.mi. The area is rectangular in plan and has steep slopes. On that account the run-off from the full area was delivered to the creek along its course at about the same time.

The creek is crossed by a double-track electric railway line, a state road, and the New York Central Railroad embankment carrying eight tracks. The electric crossing was a concrete culvert 10 ft. in span, the embankment being about 20 ft. high above the culvert. The New York Central crossing was a culvert of even smaller sectional area. At both culverts the water was dammed back so that they ran full under a head of 12 ft. in the case of the electric crossing and more in the case of the railway crossing.

The experience at the electric culvert was the more interesting. The foundation for the side walls of the structure was on heavy gravel, the bottom being the natural stream bed. The rush of water through this opening with the head of water caused scour to such an extent that the walls were undermined and sank two feet at a point about 30 ft. from the point of entrance. The spandrel walls at either end were broken at the center of the arch and separated from the barrel of the culvert along a transverse construction joint. The arch of the culvert for a distance of about 45 ft., where the greatest settlement occurred, is cracked laterally and transversely in many directions, while the edges of these lines of fracture have spalled considerably, indicating that the arch is under serious strain. A section of the side wall approximately 15 ft. long separated about 4 in. along a horizontal joint from the arch ring.

As this arch settled during the process of undermining, the water followed more readily through the soft material along the barrel of the culvert, causing the earth fill on the lower end of the culvert to flow through the large opening in the arch near the spandrel wall. The electric-railroad tracks showed a distinct sag, but were subsequently brought to grade by additional material, so that traffic could be resumed.

The cause of the failure was the undermining of the arch walls, caused by the absence of a concrete or masonry invert between the side walls. As an additional precaution where culverts may be subject to water pressure, an inexpensive cut-off wall should be placed around the arch ring within the limits of the embankment.

The culvert at the New York Central crossing was an old one which had been extended at different times, the last extension being of concrete, while the former construction was of the stone-arch type. The greater portion of this structure was washed out.

The embankment under the four main tracks and the crossover for traffic going to the West Shore tracks was washed away, leaving the rails and ties suspended across the gap. Track watchmen were on hand, which prevented accident. The railroad forces were on the site promptly with piledrivers, wrecking cranes and many cars of piles and heavy timbers making repairs (see Fig. 2).

An estimate of the maximum discharge of this creek, from observations taken after the storm subsided, would indicate an approximate flow of 1,500 cu.ft. per sec. As

*Resident Engineer, Mohawk River District, New York Barge Canal; Mark Building, Amsterdam, N. Y.

stated, the watershed covers about 800 acres. One of the old formulas used in designing small culverts is

Area of opening $= c \times$ *drainage area in acres*

where c is assumed to vary from 1 to 4, according to the slope conditions of the drainage area. By this formula the culvert was much too small.

Soil-Bearing Test with Confined Plunger

The Detroit-Superior viaduct, Cleveland, has most of its piers founded on piles driven in hard clay. Driving these piles was very difficult, and in redesigning the east abutment and one pier the engineers believed that the foundation piles should be eliminated. To verify this opinion a bearing pressure test of the soil was made, as shown by the view in Fig. 1.

FIG. 1. SOIL-BEARING TEST AT LOAD OF 8 TONS PER SQ.FT.

The test was carried up to a loading of 13½ tons per sq.ft., at which the settlement was about two inches. The settlement readings were very slight up to a load of 8 tons per sq.ft., which may be considered the equivalent of a yield point, and was so interpreted. The relation between settlement and load is shown by curve in Fig. 3. Each load was left on for a certain length of time before more load was added, and at most of the loads settlement occurred in this waiting period. Separate settlement-time curves for these intervals are shown in Fig. 4. The curves were plotted by A. W. Zesiger, bridge engineer, Cuyahoga County, who is in charge of the viaduct work. The testing arrangement, shown by the sketch Fig. 2, is interesting in the use of a confined plunger. A base-block 2 ft. square, set on the bottom of a square sheeted pit about 4 ft. on a side, is surrounded by a 6x12 curb fastened to the sheeting by a nailing strip. Clay packing is put between the sheeting and the back of the curb to prevent the rising up of the bottom soil in this space. The clearance between curb and plunger is ¼ in., the inside size of the opening of the curb being ½ in. larger than the plunger. The effect of this arrangement seems to have been complete prevention of any rising-up of the soil, so that the full bearing power of a buried foundation was presumably realized. The clay subsoil found at the site is particularly liable to lateral flow and heaving up at un-

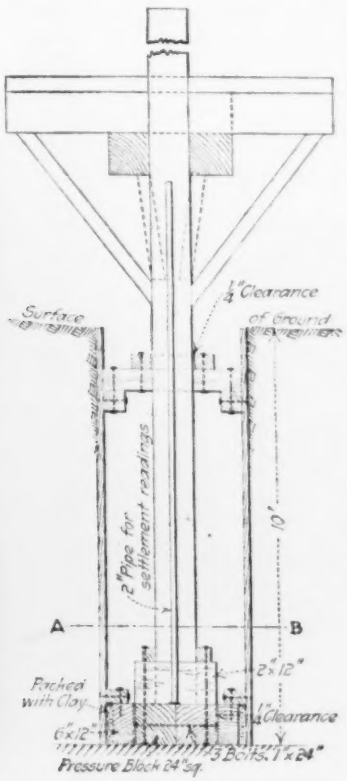


FIG. 2. SKETCH OF RIG FOR SOIL-BEARING TEST

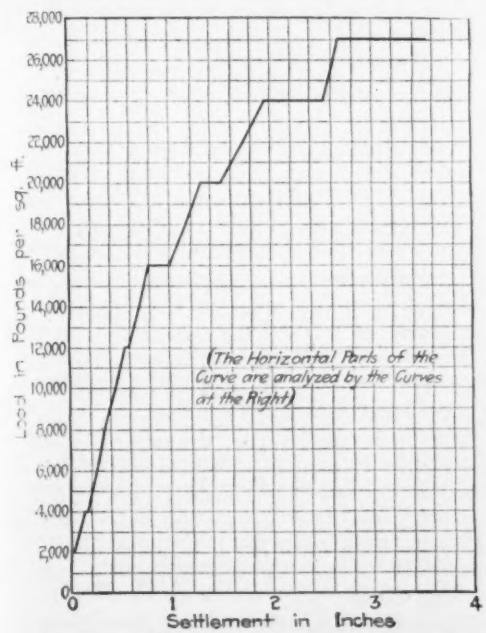


Fig. 3. Increase of Settlement with Load

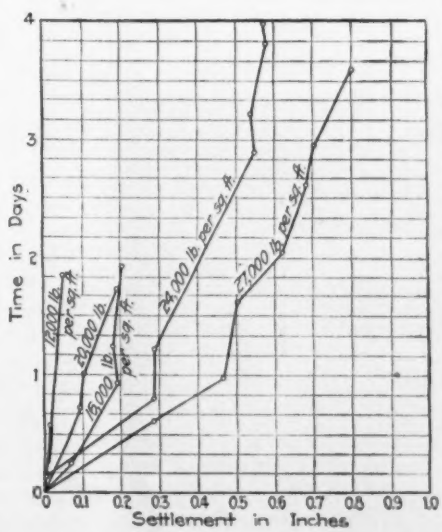


Fig. 4. Settlements at Constant Load

FIGS. 3 AND 4. ANALYSIS OF SOIL-BEARING TEST AT DETROIT-SUPERIOR VIADUCT

loaded points under the influence of a concentrated load, so that the precaution was particularly necessary in this case.

Load Test Under River Piers

The river piers of the same viaduct were founded by concreting under water direct on the clay bottom of an excavation inside a coffer-dam without piles. To verify their bearing capacity a load test of the bottom soil was made after a 16-ft. depth of the pier substructure concrete had been placed. A well 36 in. in diameter was cored in the concrete, and a 34-in. diameter plunger was set on the bottom soil in this hole. A load of 10 tons per sq.ft. on this plunger produced a settlement of 0.21 ft. The foundation was approved on the strength of this test.

New Sewer Inlets at St. Louis

By S. Chivvis*

The Division of Sewer Design of the Engineering Department of St. Louis has recently made some important changes in its standard types of street inlets and in its policy of trapping them.

Heretofore all inlets connected directly to the sewers have been built with catchbasins and have been trapped

*Office Engineer of Design, Sewers and Paving, Board of Public Service, St. Louis, Mo.

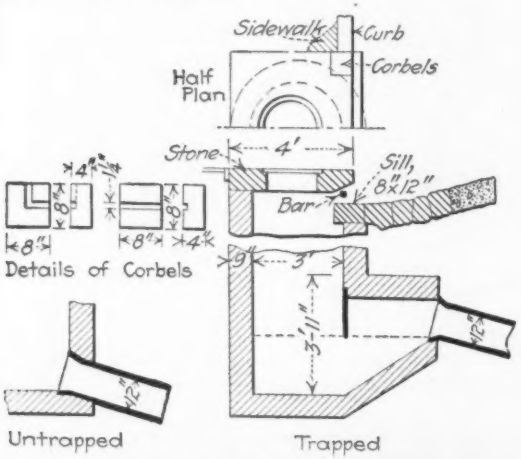


FIG. 1. OLD SEWER INLETS

FIG. 2. EXTERIOR VIEW OF OLD SEWER INLET

as shown in Fig. 1. This type (see also the view, Fig. 2) has been rather expensive on account of the massive brick neck and heavy stone. The corbels at either side of the opening, which were primarily intended to support the two front corners of the stone, are complicated by the necessity of molding into their upper surface inserts to admit the bar. The sill, which should be shaped to allow the water to drop suddenly and surely from the gutter into the inlet, has not accomplished this end, having a broad flat upper surface laid horizontally.

The result of the last-mentioned defects has been that a large amount of the water for which the sidehill or lateral sewers have been computed has rushed past the inlets it should have entered, and gorged those at the foot of the grade.

The difficulty has been met partly by a redesign of the inlet itself with a slightly greater length of steeply inclined spillway and partly by closer coördination be-

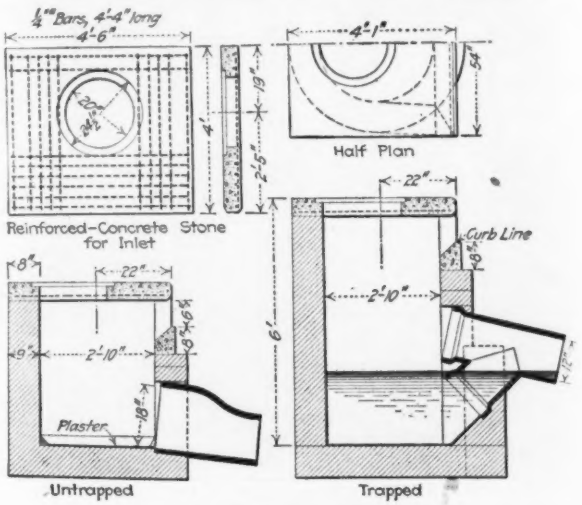


FIG. 3. NEW SEWER INLET

tween the sewer and street paving divisions in the matter of gutter depressions at the inlet face. In addition, the more sparing use of traps and catchbasins makes possible the placing of a greater number of inlets at a lower cost per unit.

Fig. 3 shows the details for both the trapped and untrapped types of the new design. The use of the trapped type with catchbasin is contemplated on inlets connected to sewers of flat grade where, on account of the sluggish flow, septic action will have a chance to begin, and on inlets draining telford streets on grades steep enough to allow the gravel to wash into the gutters. This latter case could of course be met by the use of the catchbasin alone, but the standard trapped inlet is used to avoid a multiplicity of types. All inlets not falling into the two categories mentioned will be untrapped.

With regard to the stone or cap, the old St. Louis practice called for hewn limestone of a thickness of 8 in. With the advent of concrete this thickness was retained, no reinforcing being used; but the natural eagerness of contractors to push their work led to a great number of breakages caused by loading and unloading these stones when comparatively green.

The new cap design saves 45% in weight (967 lb. complete, compared with 1,740 lb.) while adding materially to the strength under live-loading. This strength

makes unnecessary the use of corbels to support the overhanging corners, and the absence of corbels allows a greater length of spillway with a smaller stone, the new dimensions being 4x4½ ft., while the old were 4x5 ft.

Cost of Motor-Truck Hauling Depends on Conditions

Engineering News of Sept. 16, 1915, published an article by D. P. N. Little in which he described how a motor truck and trailer hauled two 11-ton girders 61 ft. 10 in. long a distance of 24 mi. from the Los Angeles shops of the Union Iron Works. He compared the cost of transportation of these two girders with the costs submitted in my article on "Motor Trucks for Heavy Structural Steel" for the Jerome Ave. elevated railway structure in New York City, *Engineering News*, July 22, p. 174. Mr. Little succeeded in cutting his costs of hauling these girders to approximately one-half the cost of those hauled on Jerome Ave. I think it is only just to explain the differences in the costs of the two pieces of work.

The average length of haul on the Jerome Ave. section is two miles, a greater part through unpaved streets with barely room for a truck to pass between the storage piles of girders, which compelled slow and careful operation. In a 10-hr. day these trucks are in actual operation only half of the time; the other 5 hr. is consumed in loading and unloading, the unloading being done by hand. It is obvious that the trucks are making only half the ton-mileage in a 10-hr. day that they would make if they were in continuous operation, as in Mr. Little's case, where the distance between the shops and the girders' destination was 24 mi. "over thoroughly improved oil-macadam roads."

Again, the assumption of $20 per day per truck is liberal, but by no means in excess of the actual cost of maintenance, which runs high on account of the wear and tear on motor cars that have hauled as high as 25 tons on a load. The costs submitted by me have run over a period of nine months, during the most inclement months of the year, as compared to Mr. Little's assumptions for depreciation of motor cars and trailers, derived from a service period of two or three days.—William Collins, Jr., Inspector for Public Service Commission, New York City.

An Underrated Contributor to Steel Construction

By R. Fleming*

The history of bridge and building failures is mostly a story of faulty details. Seldom has a structure given way for lack of strength in the main members. But eccentric rivet connections bringing about large bending moments, connections that induce secondary stresses, insufficient lacing of compression members, have all invited disaster. In the final analysis the cause of failure has been that the importance of the detailer's work was underrated. The recent failure of the Panama crane "Ajax" might have been averted if there had been more knowledge shown in the detailing of a large compression member.

*American Bridge Co., 30 Church St., New York City.

The draftsman often does not realize that his opportunities are of enough importance to call forth his best energies and the use of all the knowledge he may possess. The graduate from a technical school is apt to regard the time spent in the drafting room merely as a stepping stone to something else. He does not think it worth while to make the occupation permanent. The highly standardized systems in use in the drafting rooms of the large structural-engineering offices prescribe so much that he thinks there is no call for initiative on his part. The practice of some firms of drawing their supply of draftsmen from evening and trade schools or from an apprentice system tends to lessen the value of a knowledge of mechanics and the laws of stresses.

Money Can Be Saved by a Detailer

Aside from averting failure, the draftsman can do much in lessening the cost of shopwork. Countersunk rivets are expensive, yet how often the base of a column is filled with them when half the number would answer. The writer once made designs and estimates for a series of roof trusses to be used as standards. About the time they were finished it was found that a truss detailed in the drafting room weighed less than the standard truss of the same span, loading and main members. The draftsman, by an ingenious arrangement of field splices and a careful study of details, had effected a saving of at least $200 on the estimated cost of the roof. A careful scrutiny of his work showed no lack of strength or nonconformity to rules or instructions. Of course he could have made no such saving on every roof. It would not have been made on the roof in question if the span had been 2 ft. more or 3 ft. less.

Structures are sometimes detailed with but little regard to transportation, making freight rates excessively high because of space occupied. This is particularly true of export work. The cost of field riveting and the rates for transportation should be carefully compared and studied.

A Thousand Dollars Lost in Erection

Another opportunity of the detailer is to bring about ease of erection, thus saving field costs. One large structural firm makes a specialty of a final examination of all working drawings in order to eliminate every possible field rivet. The erector of an office building in Philadelphia was put to an expense of $1,200 for cutting out and replacing rivets in columns. The columns were made of 8- and 10-in. web plates, four angles and two cover plates. Without giving the subject much thought or making inquiries, the detailer assumed that the erector could spread the columns and drop the connecting girders between them. At the site this proved so difficult that it was found cheaper to cut out rivets, swing in the girders, and then drive new rivets. If the connections had been properly detailed, $900 of the $1,200 could have been saved. Insufficient clearances are also fruitful causes of trouble and expense. These can usually be avoided by previous study in the drafting room.

The remedy for poor and expensive detailing lies partly with the draftsman and partly with the firm that employs him. Greater inducements should be held out by firms than are offered at present. The ideal draftsman is a designer—a designer of details.[1] Estimating his value

[1] "The Designing of Details," "Engineering and Contracting," Feb. 10, 1915.

from the cost per sheet of his drawings or the cost per ton of material detailed may be misleading. A few years ago the contract for a complicated steel structure in the Pennsylvania coal regions was awarded to a firm of limited experience that had considerably underbid all competitors. One cause for the low bid was that the assumed cost of drawings was about half that of other bidders. However, by hiring students at nominal wages from a near-by technical institution, the firm succeeded in having the drawings made within the estimated cost. But the cost of erection! Every dollar saved in the drafting room cost two in the field.

What is usually considered the designing of a structure may be comparatively easy, but the detailing may be difficult. The rewards for good detailing should be commensurate with the service rendered. This does not mean that the designer should receive less salary, but that the detailer should receive more. And as previously mentioned, he should be a designer of details and recognized as such.

Testing Large Water Meters

A new equipment for testing water meters of 3-, 4- and 5-in. sizes was installed at the testing laboratory of the St. Louis, Mo., water-works in 1914. The special features of this equipment are an air cushion for water hammer, a quick-opening valve, a sliding joint to accommodate meters of various lengths, clamps instead of bolts for holding the meters between the flanges of the machine, pressure gages at inlet and outlet ends of the meter, various sizes of orifices, and an overhead trolley.

All fittings, except where otherwise specified, are wrought iron; the air cushion is a section of 12-in. cast-iron pipe about 4 ft. long; the 50-cu.ft. measuring tank is a 12-ft. section of 30-in. cast-iron pipe set on a concrete base. There is a drain from the dished concrete foundation under the meter connection to the sewer.

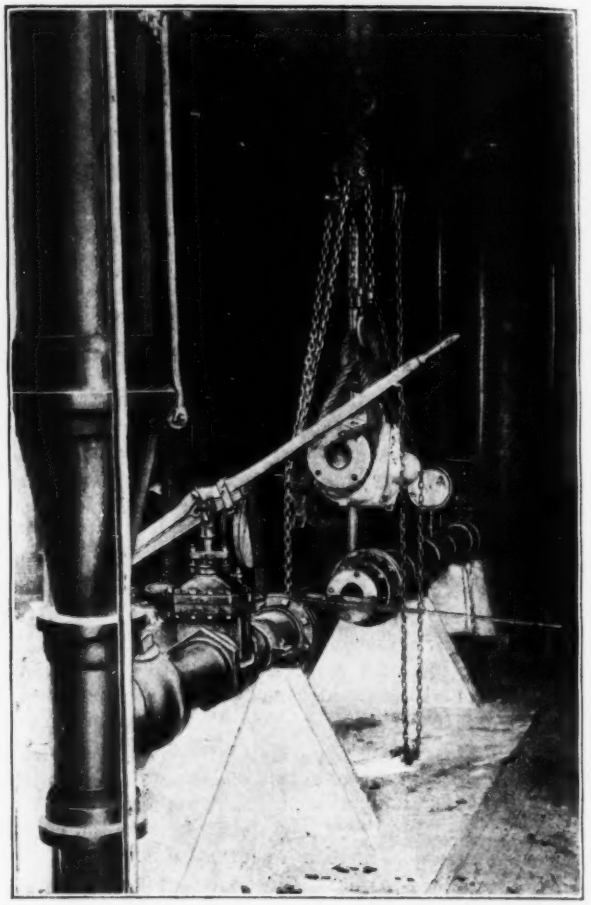
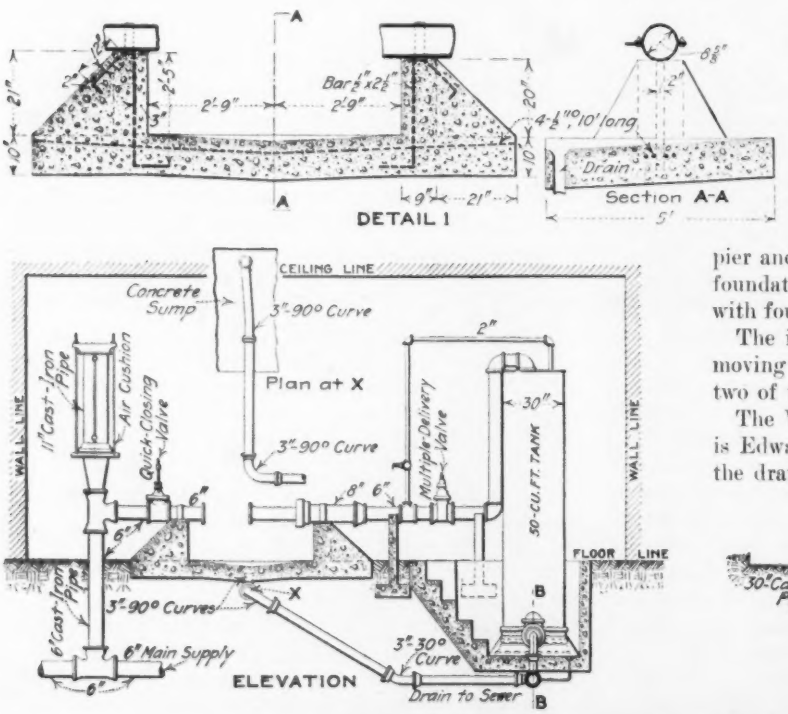


FIG. 2. VIEW OF ST. LOUIS TESTING PLANT FOR LARGE WATER METERS



The ends of the 6-in. wrought-iron pipe to which the flanges of the meter connection are attached are held on their concrete piers by wrought-iron bands riveted to ½x2½-in. iron straps bent to conform to the outline of the pier and bedded in the concrete. The concrete foundation under the testing pit is reinforced with four ½-in. round bars, as shown in Fig. 1.

The illustration, Fig. 2, shows the lever for moving the sliding connection in or out and also two of the clamps for fastening on the meters.

The Water Commissioner of St. Louis, Mo., is Edward E. Wall, to whom credit is due for the drawings and information given.

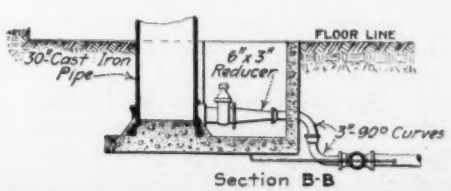


FIG. 1. EQUIPMENT FOR TESTING LARGE WATER METERS, ST. LOUIS, MO.

Large Steel Grandstand for Automobile Racetrack

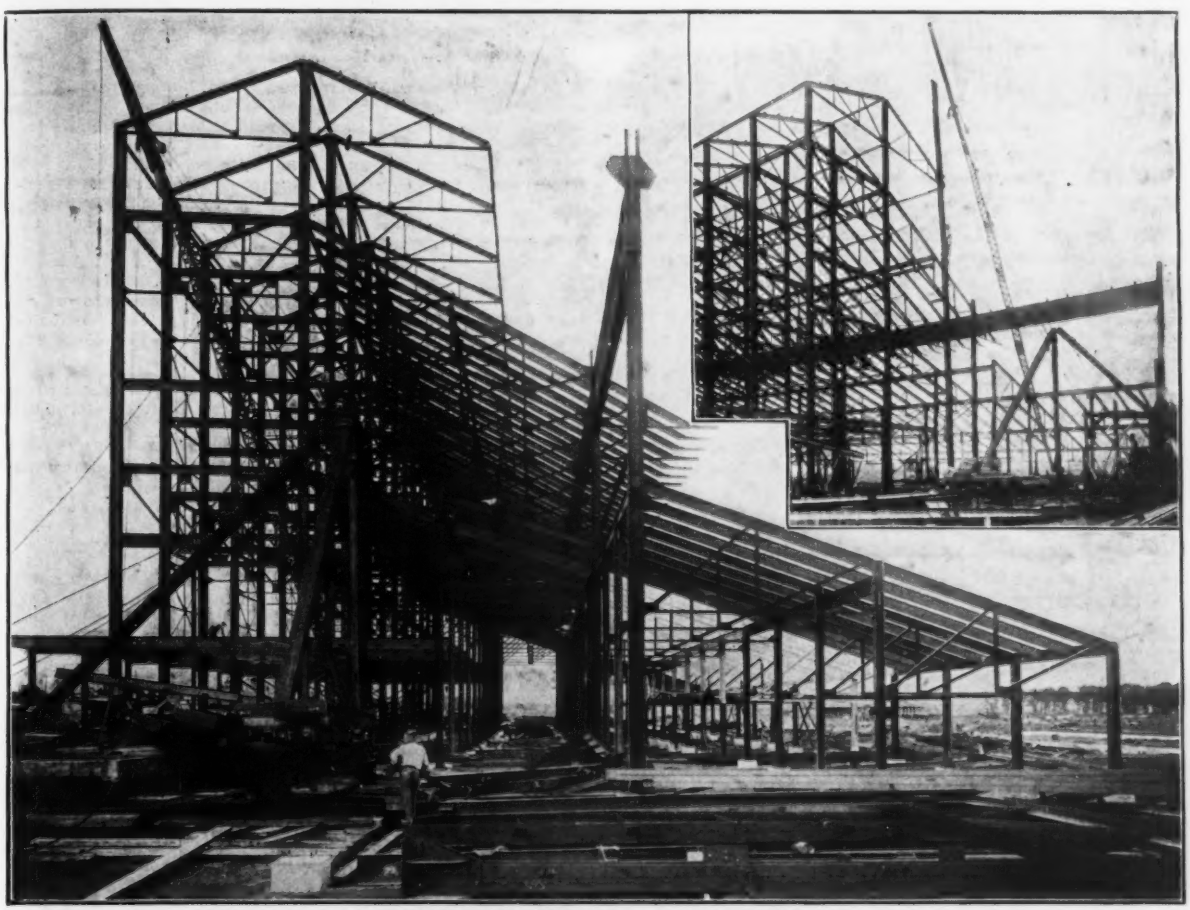
The costly two-mile racetrack for automobiles at Sheepshead Bay, N. Y., nearly completed, has a grandstand ranking among the grandest in the world. It is 1,200 ft. long by 110 ft. deep in plan, has two seat-banks and in front of the lower one a four-tier line of boxes, and contains some 2,700 tons of steel. The boxes are framed in wood. The two views herewith, showing the framework during erection, exhibit the arrangement clearly.

Fore-and-aft bents of six columns carry the trusses of the seat-banks and roof. The bents are spaced 16 ft. 4 in. apart, but the front line of columns under the balcony is spaced 49 ft. (that is, there is a column at every third bent only) to reduce the obstruction of view from the upper half of the main seat-bank. Longitudinal bracing between bents occurs in alternate bays of the three main column lines, and in every fourth bay of the other three lines. The fore-and-aft bracing consists of portal trusses under the seat-banks. Field-connections are riveted.

The five bays of the bent are 17 ft. 5 in. to 21 ft. 6 in. long, giving a depth of 93 ft. for the main part of the stand. Back of this is a three-story extension one bay in depth, containing longitudinal corridors and toilet-rooms.

The steelwork is of normal design and detailing throughout. The seat-bank stepping is carried by fore-and-aft I-beam joists, which divide the bays of the frame into three spaces. The stepping is built up of 2x6 studs supporting risers and treads (or seats), all built up on spiking strips bolted on top of the I-beam joists. The seat proportions are 10½-in. rise to 32-in. tread in the main bank, and 16½-in. rise to 32-in. tread in the balcony, or slope-ratios of about 1:3 and 1:2 respectively. The roof consists of asbestos shingles on sheathing on wooden purlins, with wooden outlookers to carry the eaves.

The height from ground to top of main seat-bank is 35 ft., to top of balcony 65 ft., and to peak of roof 84 ft. This required using a boom spliced out to 90 ft. long, on the derrick traveler (see views) which erected the main members of the framing. This traveler was carried by four two-wheel trucks running on a two-rail track laid longitudinal to the grandstand near the middle of the depth. It could reach all parts of the bent.



GRANDSTAND STEEL PARTLY ERECTED; DERRICK IN FOREGROUND

Blaine H. Miller, Chief Engineer of the Sheepshead Bay Speedway Corporation, was in charge of design and construction. The Lackawanna Steel Co. furnished the steel, and the Lackawanna Bridge Co. erected it. Erection began June 5, and by Sept. 17 the steelwork had received its final coat of paint.

Although in an outlying district, the racetrack is within the city limits, and the New York Building Code governed. Plans were approved by the Bureau of Buildings of the Borough of Brooklyn, which required the seating banks to be designed for 75 lb. per sq.ft.

NOTES

Batch Mixers To Be Rated By Mixed Batch—Some mixer manufacturers rate their machines by their capacity in mixed concrete, while others rate them by their capacity in loose unmixed material, although it is a well-known fact that a mixer having a batch capacity of 8 to 9 cu.ft. of unmixed sand, stone and cement will hold only about 6 cu.ft. of mixed concrete per batch. The National Association of Mixer Manufacturers at its August meeting took steps toward remedying this difficulty by adopting a resolution providing for the uniform rating of batch mixers. This resolution provides that the members of the association in future catalogs and circulars shall specify the capacity of their mixers as "size of wet mixed batch," and not otherwise. The dry unmixed capacity of a mixer, says the association, may be approximated at 1½ times the wet mixed batch, assuming the use of cement, sand and 1½-in. crushed stone, with 1¾ gal. of water per cubic foot of mixed concrete. The members of the association further agreed not to use the dry-batch rating in their correspondence, advertising, etc., unless the standard wet-batch rating was used also and with equal prominence.—From H. E. Smith, Secretary, National Association of Mixer Manufacturers, 1125 32nd St., Milwaukee, Wis.

Highway Signs Made of Old Saws—A unique sign for marking the various highways has been devised by Arthur P. Denton, of Seattle, Engineer of King County, Wash. Discarded shingle saws have been purchased, the rust removed and the steel disk painted as shown in accompanying sketch. The saws can be purchased in bales for practically the price of crating and taking them away from the mills, and as this is particularly a lumber country, the signs are peculiarly

HIGHWAY SIGN MADE OF OLD SHINGLE SAW

appropriate. To protect the signs from mutilation at the hands of hunters, and as targets for the rocks of small boys, the Board of King County Commissioners has had posted warning notice that a term in jail would result from the mutilation of any county property, and teachers in the various public schools have been instructed to warn their small charges. Several hundred signs have been erected and more will be added from time to time as neded.—C. A. Osier, Seattle, Wash.

Handling Plaster by Wheelbarrows and a hoist was the method employed for the interior finish of a reinforced-concrete building at Stevens Point, Wis. The plaster was mixed by hand and shoveled into steel wheelbarrows. A steam hoist on the ground had its cable led through a boom on the tower of the concrete elevator, and a landing platform projected from the floor where the plastering was in progress. The end of the cable had a three-rope sling; one rope had a hook which engaged the wheel of the wheelbarrow, and the others had iron rings to be slipped over the handles of the barrow. Four men were employed: One mixed the plaster and loaded the wheelbarrows; one handled the hoist; one wheeled the barrows to and from the hoist, attached and detached the sling and held a tag line to steady the barrow and keep it clear of the building in raising and lowering; the fourth man was on the upper floor to swing in the loaded barrow on the landing platform, unhitch the sling, wheel the barrows on the floor and attach the sling to the empty barrows.

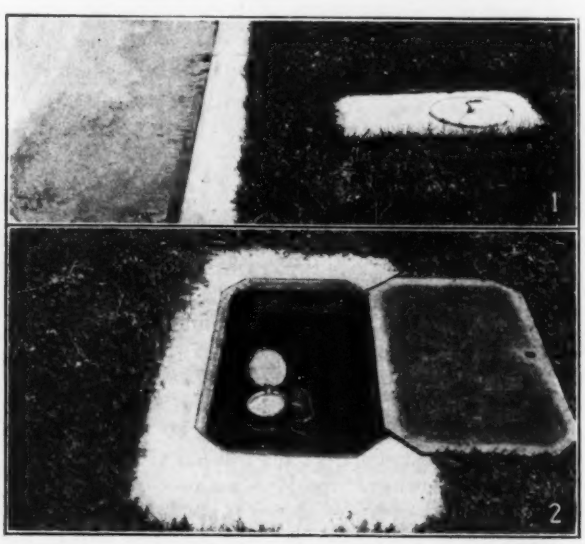
A Large Shop for plate and angle work, under construction by the Aberthaw Construction Co. for the Fore River Shipbuilding Corporation at Quincy, Mass., will be 188x769 ft. Its steel columns are composed of unusually large rolled sections, some of them 30-in. 200-lb. I-beams. The crane girders along each side of the center row of columns, as well as those along the walls of the building, are all 28-in. 150-lb. I-beams. The crane rails are about 28 ft. above the floor, while the first story reaches a total height of some 44 ft. The building is roofed with plank covered with tar and gravel. The sides are largely of glass in steel mesh, with pilasters of brick. There is one very high story for handling plates and angles for shipyard work. A partial second story above this includes the mold loft, 605x92 ft., and the sheet-metal shop, 164x92 ft.—S. G. Koon, Boston, Mass.

Using a Pneumatic-Hammer Drill Under Water is described by Charles A. Fritz, who during the summer and fall of 1914 was engineer in charge of the construction of a sewer outfall at Manchester, Mass. The outfall extended 2 mi. into tidal waters ranging in depth below mean low water from zero to 40 ft. At a depth of about 16 ft. two small ledges were encountered in the trench. The contractor (the T. A. Scott Co., New London, Conn.) had a timber crib, which was to be used to support a steam drill on a tripod. Mr. Fritz suggested the use of a "Jackhamer" pneumatic-hammer drill, which was successfully tried. The only drawback to this use of the drill was that the exhaust annoyed the divers, but this was easily remedied by bringing the exhaust to the surface by the use of a common garden hose.

Reducing Square Feet to Acres—Mr. Andrews' short cut in computing acreage ("Engineering News," Sept. 9, 1915, p. 512) involves two multiplications. Try this:

Square feet multiplied by 0.000023, minus 0.02 for each figure in the result in all ordinary cases; or, where accuracy within 0.001 is essential, subtract 0.019 instead of 0.02 for each figure or integer.—C. M. Lawrence, County Surveyor, Hughes County, Holdenville, Okla.

Cement Water-Meter Boxes of two types now being used by the City of Pasadena, Calif., are shown by the accompanying views. The smaller of the boxes shown (Fig. 1) is about 10x18 in. in plan and 14 in. deep and its walls are about 1½ in. thick. The round cement lid is lifted by a piece of heavy cord.



CEMENT WATER-METER BOXES, PASADENA, CALIF.
1—Small box with cement lid. 2—Large box with iron lid

A box for larger meters (Fig. 2) is 14x30 in. in plan, 18 in. deep, has walls 2 in. thick and is provided with an iron lid.—From Arthur Marple, Tropico, Calif.

Editorials

Safety in Subway Construction

The coincidence of two serious accidents in the subway-construction work in New York within three days has aroused uneasiness to the point of alarm. City officials share with the general public the uncomfortable suspicion that miles of timbered streets over the excavation for new subways are unsafe. The feeling is justified. Coincidences inevitably are suspicious. The first accident, Sept. 22, was alarming enough, with its mysterious spread of a local collapse to a general wrecking action that traveled along the timbering up to the point where permanent steelwork was in place. When the same contractor's work was visited with a second collapse only three days later, the municipal authorities became aroused. The coincidence struck even the slowest mind. A third collapse, however accidental, would probably make the suspicion a certainty.

To conclude anything from the fact of the coincidence is wrong in the present case, however, because the two accidents were fundamentally different in character. Any engineer, and for that matter nearly any layman, will clearly recognize this from the description printed elsewhere in this issue, drawn up on the basis of observations and sketches made on the ground. The Broadway accident was due to what the lawbooks call an act of God, in this case a catastrophal rock fall. Rock falls are not quite so unforeseeable as hurricanes and floods, but they remain the ever-continuing threat in rock excavation, whether for mine or structural use. Mining engineers, who boast of the perfection of their timbering practice, admit that the heaviest proportion of mine fatalities is due to rock falls.

The Seventh Avenue collapse is unquestionably a very serious matter. But any thoughts or sentiments based on it should not be complicated by reference to the Broadway accident.

What is more, if the relation between the two accidents is rightly interpreted the second collapse is reassuring with regard to the very danger which the first collapse seems to point out. The alarming thing about the Seventh Avenue collapse was its spreading from the point of initial failure. The man in the street concluded that the underground falsework was built more or less like a house of cards, that a loose or weak construction was being employed to support streets carrying heavy and dense traffic, and that therefore anything was liable to happen along the work, since the slightest give or fall at any one point would spread, tearing down whole block-lengths of streets. If this same man considered the circumstances of the Broadway accident, however, he could see good proof that the street supports are in fact robust and stable. The impact of hundreds of tons of rock against the timbering brought down only the little section of the street directly over the slide; immediately alongside, the posts and struts held, while the broken parts pulled clear.

Judging from the present attitude of New York City authorities and citizens, it seems to have been the popular idea that subway construction is a class of work which is 100 per cent. safe. The city officials themselves appear to have joined in this belief, forgetful of the fact that engineering construction enterprises of large magnitude cannot be wholly divested of risk. Cutting away the earth and rock under long lengths of city streets, supporting a dense and heavy traffic over the working pit, dealing with variable rock strata and uncertain building foundations, protecting suspended pipes and sewers—such operations cannot be made mechanically regular and certain, or safeguarded against all chance happenings.

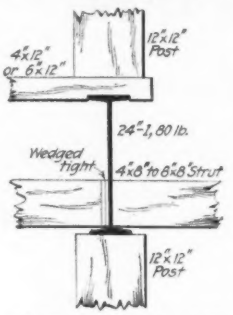
The risk remains. It cannot be eliminated, though it can be reduced, even down to a minute remnant if desired. Care and safeguard may be multiplied up to the point where added complexity and delay add danger. Increased safety-margins may be used and increased provision made against abnormal contingencies. All this, of course, is at a price. Still some risk will be left.

The present occasion is well suited, therefore, for a careful review of the subway situation to determine how much severer the requirements should be or how much more cautiously the work should be conducted than is customary in first-class engineering construction elsewhere. Some modifications, it may perhaps be found, can be made at small cost, and these will doubtless recommend themselves to all. For the rest, however, the financial question—how much can we afford to spend for it—must first be thrashed out. New York will never pay as much to safeguard Seventh Avenue against the possibility of traffic interruption as it will to safeguard Broadway. At present the Broadway and Seventh Avenue contracts are on the same footing.

But such a review must be general. To adopt only such refinements or safeguards as are directly indicated by the present accidents would be a vain measure. The same chance causes will likely not act again—others would come to light. Groups of domestic and foreign engineers have been assembled by various of the city authorities to study the timbering of the excavations. It has not been heard that investigations of blasting, dynamite handling, underpinning, water-pipes, concrete mixtures and all the other phases of the work are to be carried on. But these matters should be studied as well as the single one now in the spotlight. It is useless to shut one door to trouble if other doors are left open.

To discuss the original and most interesting element in the situation, the great collapse in Seventh Avenue, is not easy while the official inquest is yet to be held and many points of evidence must be brought to light. These will probably refer to the origin of the collapse, however, a matter which is only of minor interest to engineers. As to the timbering itself, fairly good data are given by the sketches elsewhere in this issue and a word of comment is possible and indeed inevitable.

The weak-kneed makeup of the post system is the striking feature of the timbering. Drawn in true proportion (see sketch alongside), it is an assemblage that the structural sense hesitates to accept. Instability of the post as a whole and doubtful stability of the I-beam forming its middle section are inherent in the assemblage. In the absence of longitudinal bracing in the structure, nothing to hold the posts from buckling except the spreader timbers between the I-beam webs, a moderate disturbance of the middle of the post system would be able to bring down a whole forest of these posts. As to whether this was the actual happening in the collapse of Sept. 22 can only be speculated. A blocky piece of the bench, shot out by a blast so as to hit the forward one in the tier of I-beams, could readily start the buckling of the posts.



POST SYSTEM AND MAIN BEAMS

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State Control of City-Owned Utilities Much Needed

The need for as complete supervision over municipally owned utilities as over private companies has been presented in the editorial columns of *Engineering News* from time to time and from various viewpoints. Necessarily, in these discussions there has been little specific information presented on the experiences of any of the public-service commissions of the country and no data on the extent to which the municipal utility departments have been lax. Naturally, these are matters on which the commissioners and their engineers have felt hesitant to speak. Therefore it is of special interest to show specific information on the way in which utility regulation works out in its daily detail and to give definite comparisons between municipal and private utilities. Some notes of just this sort are found in a paper by C. M. Larsen, Chief Engineer of the Wisconsin Railroad Commission, printed in the September *Journal* of the American Water-Works Association.

Wisconsin is generally looked on as one of the most enlightened states in the matter of utility regulation, and it is one where equal demands are made on public and private enterprises. But evidently the responses are not uniformly satisfying. In 1914 there were 196 privately owned electricity works and 72 municipal plants. There were 26 private water companies and 163 municipal water departments. All the telephone systems and gas-works were under private control. Of the private electric plants 53% made unsatisfactory reports and so did 71% of the municipal departments. Among the private water companies 42% made unsatisfactory reports and 71% of the municipal water-works were lax. Interest in the development of the respective utility arts is reflected in the membership of utility associations. Seven of the 26 privately owned water companies had joined one or the other of the major water-works associations, which is far too few, but worse yet only 10 out of the 166 municipal water departments were represented. In the state electrical association, whose membership probably comprises practically all the local private companies, there were four departments and five individuals representing municipal works.

Continual violation of commission regulations has required repeated inspections to hold up the service standards established. The troubles were usually excess voltage or gas pressure, low heat value of gas, failure to test customers' meters, and unsatisfactory reports. (No standards were then imposed on water-works.) In all of these ways the private companies were the lesser offenders and showed a more stable management. At one municipal electric plant the engine broke down and lighting was entirely discontinued. An inspector arrived on the scene, hunted up a traction engine, connected it to the generator and restored the service. The water department of a large city was found to be pumping raw river water into its mains. The commission on investigation found vacant land near-by from which a good well supply could be developed. The city was required to develop the project, install pumping machinery and safeguard its customers.

All this evidence points to the great need for adequate means of holding the municipal utilities to the same standards of service which it is reasonable to demand of the private concerns. Could a multitude of little local regulating commissions have coped with the situation successfully? In each case of inferior service an experienced board with a staff of well-trained engineers, accountants and inspectors has been necessary to assist and supervise the weaker utilities. Few of the local municipalities could have afforded such an organization, and without it all effective control would have disappeared. Moreover, attempted regulation of one department by another branch of the same municipal government would have usually produced no benefit. "Home rule" pushed to such an extreme as advocated by the opponents of state-utility regulation means no rule at all.

⁂

The remarkable progress of violet-ray water disinfection in the United States is shown by the article published on page 634 of this issue. All of the plants thus far installed are small, and many if not most appear to have been built with little regard to cost, the process being an alluring one from various points of view. The ultra-violet ray seems to be far outdistancing ozone as a means of water disinfection. Neither method has yet made much progress as a means of disinfecting municipal water-supplies, and neither is likely to overtake chlorination in popularity and cost efficiency for years to come, if ever. The company developing ultra-violet apparatus, however, is quietly working upon the problems of large-scale disinfection though it is not actively seeking municipal business at the present time.

⁂

The blowing up of the sewage-pumping station at Batavia, N. Y., on Sept. 17 adds another to the growing list of explosions which seem to be due to either gasoline or illuminating gas that has accumulated in sewers and wrecked either these or structures connected with them. The cause of these explosions should be given more study than it has yet received, and far more attention should be given to the detection and prevention of such dangers. One of the simplest of precautionary measures is never to carry an unprotected light or strike

a match in a sewer, tank or pump-well where there is the least likelihood that explosive gases may have accumulated.

⁂

Now that a letter-ballot vote of 2,024 to 592 has given the Board of Direction of the American Society of Civil Engineers a free hand to favor or oppose legislative bills for the licensing of engineers, it will be interesting to see what it will do when the next opportunity arises.

⁂

"Drink at your own risk"—meaning water, of course—is the rule of law laid down by the learned judge of Pickaway County, Ohio. More specifically: A water company need exercise only "reasonable care" to see that its supply is not infected, but a water consumer must use extraordinary care to guard against danger of infection provided the danger has become the subject of "common talk." Some details of the lawsuit in which this rule was announced are given elsewhere in this issue (page 631). Perhaps the evidence in this case warranted no other conclusion in a suit for damages, but it seems to show clearly that here was another typhoid outbreak due to a defective check valve between a polluted mill supply and the water-supply of a city.

⁂

All "topsy-turvy" would describe most city plans in America. This is no wonder, since with very few exceptions they "just growed." How difficult it is to make good this lack of planning, even in areas still largely undeveloped, and how much may be accomplished when a determined attempt is made, are shown by the first of two articles on city planning in Queens Borough, on pages 638-41 of this issue. One of the lessons of the article now printed is the need and value of a good topographical survey for any thoroughgoing city-planning task.

Letters to the Editor

Why Railway Engineers Often Fail in Highway Work

Sir—In the article headed "Give the Experienced Engineer a Chance in Highway Work" in *Engineering News* of Aug. 19, Mr. Mielly falls into the common error of assuming that highway and railroad engineering are the same thing. It is true that there is much similarity, but it is more a similarity of form than of substance. Take the question of grades. For a reasonable distance a horse is capable of exerting a pull twice or three times as great as his normal tractive power, and for this reason, within reasonable limits, one maximum grade on a highway does not of necessity limit the loads that may be drawn over it. For illustration, a series of long 3% grades may have more influence on traffic than one 5% grade. In other words, highway grades and railroad grades are two entirely different propositions. In the latter case, one maximum grade will limit the length of trains on an entire division; in the former case, a corresponding statement would in all probability not be the truth.

There is no question but that an engineer who has had several years of experience on railroad construction would be a valuable man on highway construction if he would adapt himself to the change in conditions and requirements. But that is just the rub. As a general rule he cannot or will not do so. I served my time on a railroad-engineering corps, and am quite free to admit that I received as much benefit from the experience as the railroads I worked for did from my services; but I could not help noticing that the rank and file of the men in the corps, who had been in railroad work for from ten to twenty years, were in a hopeless rut. They were excellent cogs in a powerful and efficient machine, but apart from that or a similar machine their value was certainly open to question.

This may explain why recent graduates, willing and able to learn, may be preferred to old hands who have forgotten how to adapt themselves to changed conditions. Again, a young man, fresh from school, is much more apt to exert himself in a position that pays $75 a month than an older man, who is likely to resent instructions and to think himself above the job. Blunders due to pigheadedness are usually much more expensive than those due to inexperience, and whereas the latter fault can be corrected, the former rarely yields to treatment.

B. K. Coghlan,
Associate Professor of Highway Engineering.
College Station, Tex., Aug. 27, 1915.

NOTES AND QUERIES

Concrete Ties—A correspondent inquires as to the reasons why concrete ties have not been a practical success. One of the main troubles is the disintegration of the concrete caused by vibration and pounding under traffic. Some of them have cracked and fractured. The weight, the cost, and the necessity (in most cases) of special fastenings are other unfavorable factors. Some ties have given good service, however. Concrete ties of various designs have been proposed, and several of these have been tried in the track, but only in small numbers, so that the aggregate number of such ties is very limited.

Relative Size of Engineering Societies—Referring to the footnote on p. 569 of "Engineering News" of Sept. 16, 1915, Edw. C. Sherman, of Boston, remarks that the Boston Society of Civil Engineers, which had a membership of 962 in June and has since admitted some new members, should have been given as ranking next in size to the Western Society of Engineers. Mr. Sherman also states further that it seems probable that by "Associated Engineering Society" was meant the Association of Engineering Societies, and calls attention to the fact that this association is really composed of various local engineering societies banded together for the sole purpose of publishing their proceedings jointly, so that it ought not to be compared with any single engineering society of equal size.

International Engineering Congress Opens

EDITORIAL CORRESPONDENCE

An audience of nearly a thousand assembled in the Civic Auditorium, San Francisco, at the opening session of the International Engineering Congress on Monday, Sept. 20. A large proportion of those present were men who have gained distinction in the engineering profession; and while the Pacific Coast was most largely represented, engineers were there from all parts of the United States. Seldom has a more notable gathering of eminent American engineers been assembled in this country. If the large attendance of engineers of other nations, expected when the congress was planned, was lacking, the number of American engineers present was a reward for the energy and courage of those who have labored for the success of the congress, and who persevered when the undertaking seemed most doubtful a year ago.

"This is the moment to which we have been looking forward for four years," said Dr. William F. Durand, Chairman of the Committee of Management, in calling the assembly to order. Continuing, he outlined the story of the origin of the congress, which grew out of plans made by a few members of the engineering societies of San Francisco and other Pacific Coast cities. Eight of these societies joined in planning for the event, and soon afterward the five national societies of civil, mechanical, mining, electrical and marine engineers gave to the enterprise their support, moral and financial. The joint committee representing all these societies has been at work for nearly three years and has received in time for advance publication 200 papers, while 30 more are in hand. The eleven volumes in which the proceedings of the congress will be published will contain over 7,000 pages.

Doctor Durand then presented the Honorary President of the congress, Gen. George W. Goethals, who received a remarkable ovation. After speeches of welcome by Mayor Rolph of San Francisco, and Charles C. Moore, President of the Panama-Pacific Exposition, General Goethals gave an informal address on the history of the Panama Canal enterprise, with reference not to its technical features, but to award credit to those prominently connected with it in a responsible capacity. He began with the building of the Panama Railroad in the early 50's by George M. Totten as Chief Engineer. The difficulties encountered in building that comparatively small work at that early day were quite comparable with those that have been met and overcome by the canal engineers.

Coming down to the attempt of a French company to build the canal, General Goethals said the engineering work done both by the first French company and its successor deserved nothing but praise. The failure at that time was due to maladministration by the promoters and directors rather than to the engineers.

The war with Spain in 1898 had a large influence in furthering the undertaking of the canal by the United States, not only because the run of the battleship "Oregon" around the Horn demonstrated to the public the military need of the canal, but also because in connection with the sanitation of Cuba, the cause of yellow fever and the methods necessary for its prevention were discovered. Under direction of Colonel Gorgas, who had done notable work in Cuba, the Isthmus was transformed from a pesthole to a reasonably healthy locality.

The short-lived commission originally appointed to build the canal deserves credit for obtaining, through General Davis, control of the terminals, which, under the original concession from Panama, were outside the Canal Zone. John F. Wallace, Chief Engineer under this commission, inaugurated the work of building houses and recruiting labor for the work, and he purchased the equipment that was used in construction.

To John F. Stevens, who succeeded Mr. Wallace, and his associate, Mr. Bierd, was due the rebuilding of the Panama R.R. to make it an effective tool for construction and also the accomplishment of a vast amount of preliminary work so that when the so-called Army Commission took charge, the excavation had almost reached the million-yards-a-month volume.

The basis of the reorganization effected in 1908 was that there should be one responsible head in charge of every task from the top to the bottom, so that there was never any question as to who was accountable for failure or deserved credit for accomplishment. To Col. H. F. Hodges and Civil Engineer H. H. Rousseau of the Navy General Goethals gave high praise for their loyal support and effective aid. They had been, he said, his right and left bowers.

In order to create active competition in carrying on the work efficiently he placed the Atlantic Division in charge of army engineers under Col. Wm. L. Sibert, while the Pacific Division was under S. B. Williamson and a staff of civilian engineers. General Goethals said the canal force was the finest construction organization that ever existed until the water was turned into the canal, when the desire to continue on the Government payroll became the controlling motive.

Some have claimed that the locks of the canal, 110 ft. in width and 1,000 ft. in length, had not been designed large enough for future naval vessels. If that is so the responsibility belongs to the Navy and not to the canal engineers, for before the locks were built an official board of the Navy reported the dimensions that they deemed ample for future ships and those dimensions were adopted.

In planning the organization for the operation of the canal some had claimed that the office of chief engineer should have been created under the governor. General Goethals, howver, thought that with the Zone depopulated, a governor would have little to do and probably would be a political appointee who would be constantly interfering with the chief engineer's work. He thought it far better, therefore, to give the governor entire responsibility and hoped that an engineer would always be in control of the Canal.

General Goethals then introduced the only one of the nineteen honorary vice-presidents of the congress from foreign countries who was present, Major J. L. De Pulligny, of France, who has been in charge of road maintenance for the French army over a large section of the western battle front, and who was given a two months' leave of absence by the French Government to attend the congress. Major Pulligny was for some years in the United States prior to the outbreak of the war, in charge of French engineering students in the United States. His address was notable for its eloquence.

Brief addresses were then made by delegates to the congress from Canada, Cuba, China, Guatemala, Japan, Holland, Nicaragua, Spain, Sweden and Switzerland.

In the afternoon the congress again assembled in a general session to hear half a dozen papers on the Panama Canal. Major Pulligny presided at this session. The opening paper by General Goethals reviewed the history of the canal enterprise in much more detail than in his formal address at the morning session. Space may be taken here only for the interesting fact that while the revised estimate of cost of the canal made in December, 1907, was $375,201,500, the total cost of the canal to date, including the $50,000,000 paid to Panama and to the French company and the amounts spent on fortifications, is less than $333,000,000. The remaining papers at this session were by Dr. Emory R. Johnson, on "Commercial and Trade Aspects of the Canal"; Maj. R. E. Wood, on "The Working Force of the Canal"; Maj. F. C. Boggs, on "The Purchase of Supplies"; D. F. MacDonald on "Canal Zone Geology," and F. D. Willson, "Climatology and Hydrology of the Canal."

In the evening a reception was held at the Palace Hotel for all the members of the congress and their ladies.

On Tuesday morning began the separate meetings of the eleven sections of the congress devoted to special fields of engineering.

National Engineering Societies Meet in San Francisco

EDITORIAL CORRESPONDENCE

Engineers from all parts of the United States, with representatives of the profession from foreign countries, began a notable series of meetings in San Francisco on Thursday, Sept. 16.

The American Society of Civil Engineers held its annual convention at the Hotel St. Francis on Thursday morning with some 400 in attendance. President Charles D. Marx, of Stanford University, delivered the annual address, taking as his subject, "Idealism and the Engineer." He urged that the engineer is as truly an idealist as the artist or the poet. Every engineering work must exist in the imagination of some engineer before it can assume physical form. Whoever does his duty at personal risk in a useful work is a hero as truly as those who risk their lives in warfare.

Professor Marx alluded to the fact that the head of the Belgium Relief Commission, Herbert C. Hoover—of whom prominent Belgians have said, "Hoover is the hope of Belgium"—is a member of the Society. Taking illustrations from many different departments of engineering, Professor Marx showed how great works effecting most public benefits were being performed by engineers.

At a brief business meeting following, Secretary Hunt announced that the ballot for the place of holding the summer convention of 1916 had resulted in 118 votes in favor of Pittsburgh, 51 for Boston and 48 for Washington, with many scattering.

The board of direction had recommended that the Society by letter ballot should rescind its action taken some years ago opposing legislation for the licensing of engineers. The result of the ballot showed 2,024 votes to rescind the former action and 592 against rescinding. This vote leaves the board free to act on this matter according to its best judgment.

On Thursday evening a dinner was given by the San Francisco members of the Society to the visiting members.

On Friday afternoon many of the members of the Society and their guests went to Del Monte, where a golf tournament was arranged for the following day and an automobile tour from Santa Cruz to the Big Basin and San José on Sunday.

The American Society of Mechanical Engineers held sessions on Thursday morning and on Friday morning. At the first of these the engineering features of the Panama-Pacific Exposition were reviewed in papers by Guy F. Bayley, Chief Mechanical Engineer of the Exposition, and George W. Dickie, vice-president of the Society. Following this session the visiting members were entertained at luncheon on the exposition grounds.

At the session on Friday morning papers on the heavy-oil engine and the Diesel engine were presented by A. H. Goldingham, Engineer of the De La Vergne Refrigerating Co., of New York, and Prof. W. H. Adams, of Throop Polytechnic Institute, at Pasadena. These papers were discussed by C. R. Weymouth, Chief Engineer of Charles C. Moore & Co., who maintained that under the prevailing conditions of cheap fuel in the United States there were very few places where the Diesel engine could show a commercial success. He stated that the total capacity of Diesel engines now in use in the United States, after a dozen years of attempted exploitation, is only about 100,000 hp., while in steam turbines, single units of 50,000 hp. are already talked of.

A notable social event on Friday was a luncheon given in honor of the president of the Society, Dr. John A. Brashear, by Charles C. Moore, president of the Panama-Pacific Exposition. The invited guests included members of the Society's council and other noted engineers. Dr. Brashear has been named by Governor Brumbaugh of Pennsylvania as the most distinguished citizen of that state, and Wednesday, Sept. 22, was celebrated at the exposition as Brashear Day in his honor.

The American Institute of Electrical Engineers, at a special convention, distinguished itself by dealing with a long list of technical papers, 26 in number, and holding sessions both morning and afternoon on Thursday and Friday. Two and three parallel sessions were held to discuss simultaneously such special subjects as electric transmission, valuation of public utilities and wireless telegraphy. Joint sessions were held with the American Institute of Radio Engineers. The principal social event was a dinner-dance on Thursday evening.

A Pan-American Road Congress, consisting of a joint convention of the American Highway Association and the American Road Builders' Association, was held at Oakland, Sept. 13 to 17. Some 27 papers on various phases of highway construction and maintenance were scheduled for presentation. Considerable interest was aroused in the convention by the proposal brought forward by the Pacific Coast delegates that the Federal Government should construct a national highway along the Pacific Coast from British Columbia to Mexico. After discussion the project was approved in modified form as follows:

Resolved, That the Pan-American Road Congress recommends to the Congress of the United States the advisability of investigating the necessity of building a hard-surfaced highway along the Pacific Coast from Canada to Mexico, and other national highways to be used for military and commercial purposes.

The pacificists and militarists had it out on the insertion of the words "military" in this resolution, with the result shown.

Subway Timbering Accidents; Two New York Streets Fall

Blast Starts Collapse on Seventh Ave. Line

More than a block's length of New York street surface, with a fully loaded street car and several wagons, dropped into the subway excavation underneath on Wednesday, Sept. 22, 1915. The collapse was the indirect result of a regular blast in the bench at the north face of the excavation. It is not only the worst construction accident in the history of the new subway work in New York City, but it has also made the people and the officials of the city suspicious about the safety of all the many miles of timber-supported street surface over subway construction work.

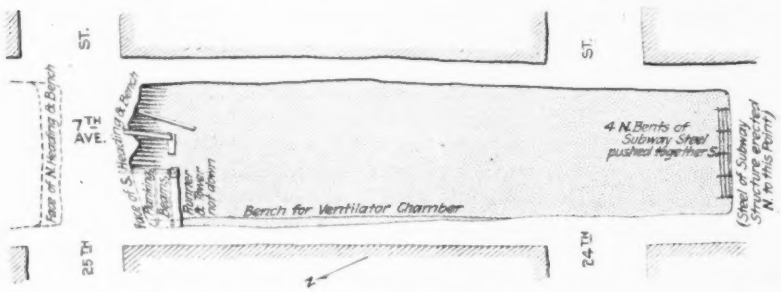

ST.
ST.
7TH AVE.
Face of N. Heading & Bench
Wall of S. Heading & Bench
Planking & Beams
Bumper & Timber roll down
Bench for Ventilator Chamber
4 N. Bents of Subway Steel pushed together 5"
(Sheet of Subway Steel curved over N. to this Point)
25TH
24TH

FIG. 1. SKETCH PLAN OF SEVENTH AVE. COLLAPSE

The accident is unexplained. Its origin—a local failure or knocking-down of timbers by flying rock or other effects of the blast—is readily understood. But no explanation has been given by the parties involved of the extension of collapse backward along the completed timbering—presumably secure and solid—for a distance of at least 300 ft., or about 30 bents. Suggestions have been made that some general cause, as a gasoline-vapor explosion set off by the blast, brought about the wreck; these suggestions are only hypothetical, as no facts have been learned to support them.

Subway work in Seventh Ave. extends south from 42nd St. to a connection with a pair of tunnels under the East River at Old Slip. All but the extreme southerly part is four-track structure with all tracks on the same level. The structure is generally as near the surface as the pipe and sewer systems permit.

The collapse occurred in the section from 16th to 30th St., which is being built by the United States Realty and Improvement Co. as contractor. The south end of this section is in sand for the full depth, while the north half is in all rock (schist). The same working system is employed in both parts, with only minor differences. As in all the subway work now going on in the city, the excavation is done underground, after replacing the pavement by planking laid on joists and beams. These beams are underpinned by girders and posts as the subsurface digging proceeds.

On Sept. 22 the excavation and timbering of the section were so far advanced that only 50 ft. of ground was left between the main south heading, which had reached the south line of 25th St., and the north heading, which had crossed the north line of 25th St. Advance work in the north heading had been shut down, and back of it most of the permanent subway steelwork (columns and roof beams) had been erected. In the south heading the steel erection had extended to a point between 23rd and 24th St., while from here north to the face of the bench the footings for the permanent steel were being prepared.

A blasting gang came on duty in the south heading shortly before 8 a.m., Sept. 22, to shoot the holes in the

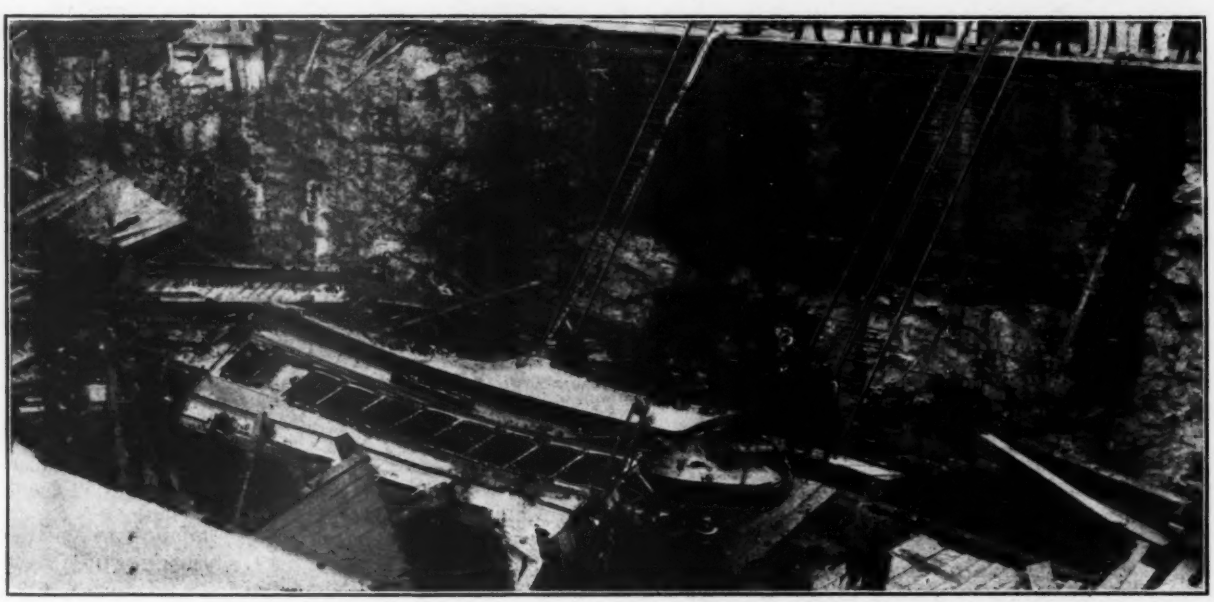
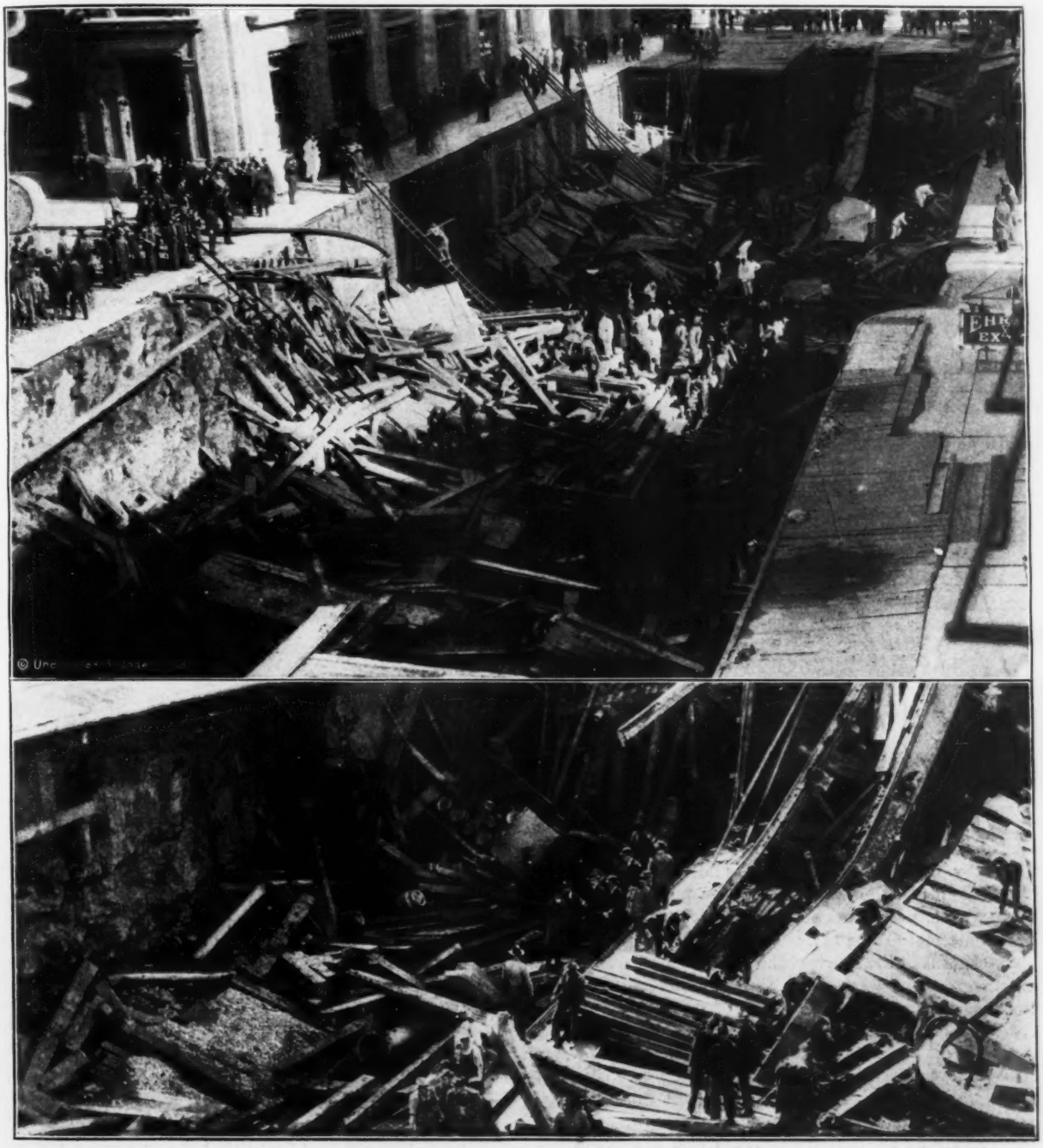


FIG. 2. LOOKING SOUTHWESTERLY INTO THE EXCAVATION AT THE COLLAPSE

east half of the bench—east and west halves being worked separately. One blast, possibly two, were shot, and then at once the whole street roadway came down, over the full width of the cut, and back more than a block, to the point where the permanent steelwork was in place (see sketch, Fig. 1). A loaded northbound street car, which was held by a flagman halfway between 24th and 25th St., fell to the bottom with the tracks, and two wagons also went down. Eight dead were later taken out of the car.

The wreck showed the roadway planking lying in fairly regular arrangement on top of the pile in the cut (see view, Figs. 3 and 4). It seems to have fallen straight down. The supporting timbers and I-beams were not so regular in position; such of them as could be identified as to original location indicated a movement south. The four or five northerly bents of permanent steel, at the south end of the collapse, were crowded together and leaning south.



FIGS. 3 AND 4. HOLE IN SEVENTH AVE., NEW YORK, AFTER COLLAPSE OF TIMBERING IN SUBWAY EXCAVATION

Upper view, looking north, shows point of initial failure at right. Lower view, looking at south end of collapse, where the street timbering was carried on permanent subway steelwork

The timber used in the United States Realty section is shown in Fig. 5. The beams under the street planking and car tracks are carried by one 12x16-in. longitudinal stringer on either side of a central aisle. Bents of 6 to 8 posts, spaced 10 ft. apart along the work, support the stringers and also directly the roadway beams. These posts in turn foot on transverse 24-in. 80-lb. I-beams, one 25-ft. length on either side, set 12 to 15 ft. above the floor of the excavation. Four 12x12-in. posts, two under each I-beam, carry the load of the entire bent.

For bracing, the I-beams are strutted longitudinally by 4x8-in. or 8x8-in. spreaders wedged between their webs. Two or three such spreaders are used on either side of the central aisle. Also, the upper tier of posts is set on 4x12-in. or 6x12-in. foot-planks dapped over the top flanges of the I-beams in alternate bays between bents. Longitudinal spacer planks under the roadway beams also act as struts.

Transversely, the two I-beams of each bent are spread and tied by a pair of 12-in. 20½-lb. channels spanning the middle aisle and bolted to the I-beam webs. There are other spreaders, and at many places transverse diagonal bracing in the upper tier of posts, as indicated in Fig. 5. The outer posts are blocked against the side walls of the cut.

There is no longitudinal diagonal bracing in either upper or lower tier of posts.

At the forward end or bench, the timbering is bridged over to the top of bench by four longitudinal flying girders or "runner beams," two on either side, which extend from a support on the bench backward over at least three bents, and rest on independent framed towers at their back ends. These runner beams are 30-in. 200-lb. wide-flange I-beams, 42 ft. long. They carry the forward two bents (nearest the bench, where posts cannot be set, or if set might be displaced by blasting) by hanger bolts holding up the 24-in. I's of the bents. As bench excavation proceeds, the runner beams are set forward in 10-ft. steps, and their rear towers are moved in 20-ft. steps.

Conditions at the bench of the south heading at 25th St. are these: The west bench system is undisturbed, the runner beam and its tower (only one beam was used in the west half of this point) being still in place holding up the street planking; just back of the runner-beam section, however, everything is down. In the east half, not only is all the timbering down, but both runner beams are down, leaning up against the bench with their forward ends nearly at its top; both towers also are down, but the inner one of the two is lying on the floor of the pit, overturned and crushed flat, not far out of place. Fig. 1 sketches the conditions roughly.

The difference between the east and west bench conditions proves that the east runner beams or their towers were displaced or wrecked in the very origin of the collapse. Had the collapse started behind them the posted timbering should have pulled clear and left the bench section standing as in the west half. The collapse of the timbering southward of the bench section was apparently a southward tipping or buckling of the post system, possibly started by a heavy blow delivered against the front end of the timbering near the level of the 24-in. I-beams.

As a precautionary measure since the collapse, longitudinal diagonals have been spiked or bolted to the lower

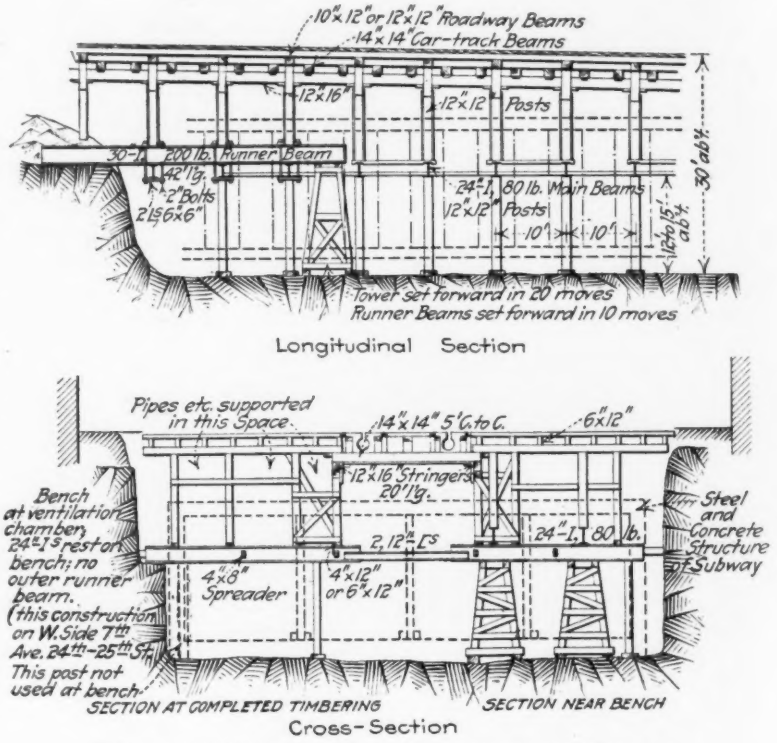


FIG. 5. ARRANGEMENT OF TIMBERING IN SEVENTH AVE.

The working system involves the use of transverse I-beams suspended from flying girders or runner beams near the face of the bench and carried on posts farther back

posts at intervals in the remaining timbering of this contract section.

Investigations of the accident have been started by the coroner, the contractors, the Public Service Commission, the Mayor and other authorities.

Second Fall Due to Rock Slide in Broadway Excavation

Only three days after the Seventh Ave. accident described in the preceding article, a second collapse of subway timbering occurred in the work of the same contractor, but on another contract section. About 7 p.m., Saturday, Sept. 25, the timbering under Broadway near 38th St. was wrecked by a rock slide. Partly crushing and partly dislocating the system of posts and brace-struts, the slide dropped the roadway planking of half the street width for a length of 70 ft. into the pit. The planking of the east half, together with the two car tracks, remained hanging across the wrecked section by the suspension action of the track rails. One vehicle fell with the street planking, causing one death.

The point of collapse is directly in front of a theater, and four or five other theaters are within a radius of 300 ft. Had the collapse occurred half an hour later, therefore, the results would have been more serious.

The work at this point is part of the new Broadway-59th st. subway line to be operated by the New York Consolidated Railroad Co. (Brooklyn system). The section from near 32nd to 39th St. is being constructed by the United States Realty and Improvement Co. The structure is to be one-level four-track subway, with floor about 35

FIG. 6. BROADWAY TIMBERING WRECKED BY ROCK SLIDE ON WEST SIDE OF CUT

ft. below street. Rock is within 5 to 6 ft. of the surface; it is Manhattan schist, whose strata here stand nearly on edge. As indicated by the elevation of the bench face in Fig. 7, the dip is to the west. On the east side of the cut (right side in Fig. 7) the rock slopes so as to slide into the cut, and here some of the slabs have been doweled in place by steel rods grouted in holes. On the west side the blasting produces an irregular side face, with sheets of rock standing up partly undercut. Jointing planes slope down inward toward the cut.

The slide (Fig. 7) was a slip along such jointing planes of the rock of the west face. The appearance of the break shows this clearly (see Fig. 7 and view, Fig. 6). What disturbance started the slip could not be learned. According to the best evidence at hand up to now, no one suspected the seamy, dangerous nature of the rock at this point. The slip was about 12 ft. in thickness at its maximum, measured out from the original side of the cut.

The timbering of the Broadway excavation (Fig. 8) is closely similar to that used on the Seventh Ave. section of the same contractor (see Fig. 5, in preceding article). The main beams, however, are set above the permanent subway structure, and thus are located just beneath the piping under the street; the posts under them are strutted by two lines of longitudinal and transverse timbers. There are four posts in each bent, two under the 12x16 main stringers and two at the walls. Bents are spaced 10 ft. The outer posts, as observed in the standing work just south of the collapse, are blocked against the sides of the cut, both to hold the rock and to stiffen the timbering; this blocking varies from post to post. However, in the collapsed section the east face of the cut slopes inward on what appears to be a stratification surface, in a way to give little opportunity for effective lateral blocking.

The extent of the collapse is indicated in Fig. 7. Seven bents just south of the face of bench are totally destroyed. Three others are partly destroyed and partly distorted by having the tops of the posts pushed over eastward. South of this the timbering is in place and plumb, and there is no indication that the collapse transmitted any injurious action to it. Nevertheless, the posts in the undamaged portion were braced longitudinally by heavy tim-

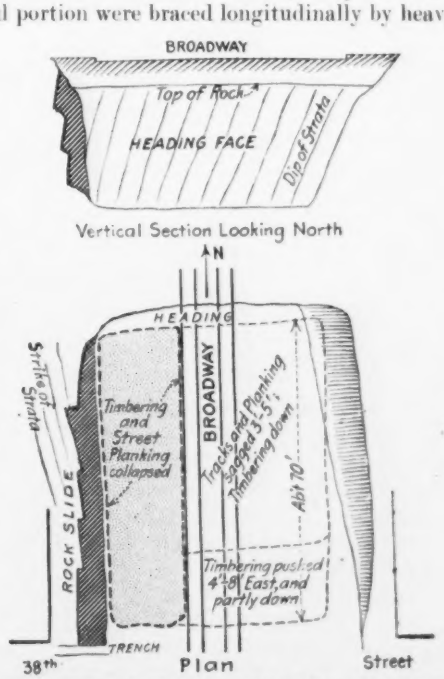


FIG. 7. SKETCHES SHOWING LOCATION OF ROCK SLIDE AND RESULTING COLLAPSE OF STREET SUPPORTS

ber diagonals immediately after the collapse, as extra assurance of security.

Where the collapse occurred the bench of the excavation had advanced to within 100 ft. of the north end of the United States Realty contract section. The adjoining section had not yet been attacked in the immediate neighborhood, so that there has been no opportunity to develop the rock structure just north of the region of the slide.

The police department stopped traffic on many of the most important thoroughfares of the city. Seventh Ave. was closed from 31st St. south. Broadway was closed from 26th St. to 39th St. to all except street cars, and from 33rd St. to 39th St. to all traffic. Crossings were closed along Broadway at 8th, 14th, 23rd, and at all crossings from 28th to 39th Sts. On Seventh Ave. the crossings of 14th, 23rd and 34th Sts. were closed, as were also the crossings of Sixth Ave. and 34th St., W. 10th and W. 4th Sts., and Christopher and Varick Sts.

This procedure stopped through traffic on the 8th, 14th, 22nd, 29th and 34th St. crosstown lines, as well as on

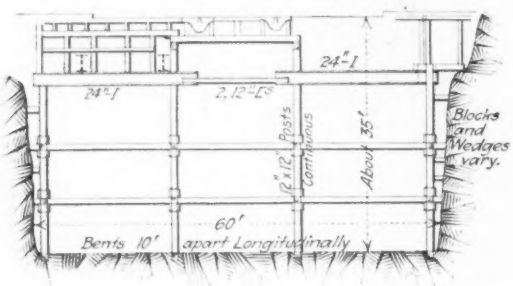


FIG. 8. TIMBERING SYSTEM USED ON BROADWAY

Arrangement similar to that used on Seventh Ave. (Fig. 5), but with main beams above subway structure and close to street surface; two sets of struts between posts

Broadway and on Sixth Ave. and Seventh Ave. This interference necessitated the operation of an improvised system of shuttle lines.

These rigorous measures were adopted by order of Police Commissioner Woods, following a resolution adopted by the Public Service Commission at its meeting on Sunday morning. The resolution was introduced by Commissioner Hayward, and recommended that all traffic on decked-over streets (except street cars) where the street supports were not of steel should be prohibited. Commissioner J. S. Cram offered an amendment to the effect that all heavy traffic be prohibited on Broadway.

This meeting was attended by all the members of the commission, its chief engineer Alfred Craven, Mayor J. P. Mitchell, and M. H. Smith, Chief Engineer of the Department of Water Supply, Gas and Electricity.

The city authorities from mayor down to Public Service Commission became enough aroused over the Broadway collapse that they appointed several experts and investigation boards.

The mayor's committee of engineers consists of the following members of the city's engineering forces: Nelson P. Lewis, chairman, E. P. Goodrich, J. W. F. Bennett, George W. Tillson, Eugene W. Stern, Merritt H. Smith, Amos L. Shaeffer, Edwin J. Fort, John R. Healy, Benjamin Welton, Francis Ferry, and R. W. Creuzbaur. For the Public Service Commission, investigations by its engineering staff will be supplemented by the services of Henry H. Quimby, Chief Engineer of the Philadelphia subways, Edmund S. Davis, Chief Engineer of the Boston subways, and J. H. Hammond, Jr.

The inquiries being conducted by the coroner and the district attorney are assisted by H. de B. Parsons as expert.

Danger of Collapse in Subways Is Not General

By Fred Lavis*

The two accidents on the new subways in New York City, occurring so close together both in time and location and resulting in the collapse of the roadway supported over the subway excavations, have, perhaps naturally, caused some apprehension in the minds of the responsible officials as to the general security of the comparatively large amount of street surface of this character now in existence. The writer made a very careful examination of all the work in progress a little over a year ago and was at that time impressed by the care exercised and the precautions being taken to avoid accidents of this kind.

It was recognized on all this work that owing to the greatly varied character of the so-called "New York rock" (the mica schist that underlies the whole city) it was impossible to predict with certainty what the results of every blast would be, and precautions were therefore taken to provide against complete collapse of the decking, even though one or even several supports were displaced either by rock thrown out by blasting or by slipping or sliding of the rock mass.

The extremely unstable character of the New York rock has always been realized, but even among the most competent of those who have had to handle it, it has not always been possible to entirely prevent trouble, as the series of disasters in 1902 in the Park Avenue tunnel of the original subway testifies.

In view of these conditions, therefore, it seems advisable to mention here briefly some of the general principles and methods adopted on the work referred to, which was described in some detail by the writer in a series of articles in *Engineering News* during the second half of 1914. This may tend to allay the fear that the conditions that have caused these last two accidents are general or that there is cause for general alarm over the situation.

Article VII of the series referred to describes the methods of timbering (*Engineering News*, Nov. 26, 1914, p. 1068), and the references herein to the figure numbers are to those of that article. At the outset it may be noted that, speaking generally, all the excavation below, say, 14th St. is in earth and above that point almost all in rock. Little danger from blasting or from sliding rock is to be expected, therefore, on the downtown sections.

At the time of the writer's examination of the construction work, and in conversations with both the engineers of the Public Service Commission and of the contractors, he was impressed by the evident realization on their part of the necessity of continuous support and the need of adequate bracing in all directions, as is shown by the following quotation from the article referred to, where it is noted that the design of the timbering in all cases not only provided for a clear working space, but was designed to

*Consulting Engineer, 50 Church St., New York City.

guard against disaster by the loosening or destruction of one or more supports by the blasting operations or by slides in the very unstable New York rock."

Taking up the references in order, it will be noted that in the fully timbered section of the usual ranger and cross-braced type (illustrated in Fig. 35 of the article cited) "tension rods were used throughout to hold up the bottom braces, and carefully placed *additional horizontal cross-bracing* was carried diagonally from the center at each of the shafts back through several bents to the sides." The vertical diagonals are shown in the photographs.

On Lexington Ave., "after some trouble with slipping and sliding rock, continuous girders were erected on the sidewalk line, spanning the section in which excavation was being carried on, and from which the street decking was hung as well as being supported from the bottom." (Figs. 36 and 41.)

Through the deep cutting for the 125th St. Station, a system of six pairs of 20-in. I-beams was used, three pairs under each track of the street railway. One pair under each track—that is four in all of these I-beams—was continuous throughout the length of the work, the joints being spliced to develop full strength; a second pair under each track—that is, another four beams—was 120 ft. long (with fully spliced joints) and they, as well as four more 80 ft. long, spanned the working space and were moved ahead as the work progressed, but they were all supported at more than one point. Unusual care was taken in all this work to splice all joints and to nail cleats at all connections. This made it somewhat more difficult to take the timber apart when it was necessary to remove it and of course damaged it more, but the structure was well framed and fastened together.

Figs. 37 and 42 show the vertical diagonals, or so-called "arch bracing" used on the section under Church St. and on Sec. 3—lower Broadway.

Fig. 40 shows a Lexington-Ave. section which was quite deep and where the rock was bad in many places. Here three pairs of I-beams spliced to develop full strength were placed immediately under the decking, one pair between the track and one pair on either side. There are three more pairs further down, and the whole structure is tied together. The vertical diagonals just below the deck form an arched support, the rakers at the side forming desirable supports, but arranged in such a way that the entire removal of even two or three at a time would not cause a collapse of the structure. Fig. 51 of the succeeding article (*Engineering News*, Dec. 3, 1914, p. 1108) shows a typical rock slide on Lexington Ave.

These references, it is believed, are sufficient to show that the difficulties and dangers of this work have been realized and at least on much of it fully provided for.

News of the Engineering World

Another Septic-Tank Decision

Another stage in the seemingly endless litigation over the Cameron septic patent in the United States has been reached by the denial of a plea entered by the defendant in one of the suits. (Cameron Septic Tank Co., complainant, vs. City of Winchester, defendant, United States District Court, Eastern District of Kentucky.) Some time time ago the company brought suit against the city, alleging that the two-story settling, or Imhoff, tank at Winchester, Ky., was an infringement of the Cameron, Commin & Martin United States Patent No. 634,423, of Oct. 3, 1899, process claims Nos. 1, 2, 3, 4, and 21. Proof on the main issue has not been submitted, the defendant pleading that the process claims just named expired in 1909 with the apparatus claims of the Cameron & Commin British patent (for 14 years) No. 21,142 of Nov. 8, 1895.

In a brief filed in May, 1915, the company denied the plea of the city and maintained that the process claims remain in force in the United States for the full 17-year term of the patent, or until Oct. 3, 1916. The United States District Court filed an order on Sept. 15, 1915, sustaining this plea. The order was not accompanied by an opinion. Unless the city appeals, the case will presumably go to trial on the main question of infringement, regarding which no evidence has yet been offered.

It may be added that in the Knoxville, Iowa, case (see *Engineering News*, Jan. 23, 1913, p. 189, and Feb. 6, 1913, p. 275) the United States Supreme Court ruled that Patent No. 634,423 expired in 1909 with the British patent already named, and that while the Cameron Septic Tank Co. maintains that ruling to be of no significance except in the Knoxville case, opposing attorneys have claimed the contrary. (For both contentions, see *Engineering News*, Feb. 6, 1913, as cited.)

Activated-Sludge Progress at Milwaukee, Wis.

Rapid progress with activated sludge as a means of sewage treatment is being made at Milwaukee, Wis. The status of both construction and experimental work is shown in the following statement prepared for *Engineering News* by T. Chalkley Hatton, Chief Engineer Milwaukee Sewerage Commission:

Three tanks of the 2,000,000-gal. unit will be in use by Oct. 1 in order to secure activated sludge for priming the entire unit, which will be completed by the middle of November.

The experimental continuous-flow tank which has been in operation since July (see *Engineering News*, July 15, 1915) has been giving splendid results. The volume of flow through the tank has been gradually increasing and the amount of air required for aeration decreasing, until now (Sept. 24) the sewage is being treated at a cost of about $4 per 1,000,000 gal., and that, too, with a resulting effluent that is stable, clear as tap water and that shows a bacterial reduction of between 95 and 99%.

We have gotten so far along with our experiments in the treatment of the liquor that we have no doubt in our minds of its success both from the sanitary and economical

standpoint, and we are now investigating very earnestly the disposition of the resultant sludge.

We have had this sludge analyzed by two fertilizing manufacturing companies, who have given us its available value based upon the nitrogen and fat content of about $12. We have been assured that there is an ample market for it as rapidly as it can be manufactured, and we are now engaged in making a study of the best apparatus for dewatering, degreasing and drying the sludge, and we think there will be no difficulty in securing proper apparatus for performing this work economically so as to leave a considerable margin of profit in the output.

Wind Wrecks Wireless Tower at Tufts College

By Frank B. Sanborn*

A high wind wrecked a 300-ft. wireless tower under erection by the American Radio and Research Corporation at Tufts College, Mass., on Sept. 26. The top section of the tower had just been put in place, but was not permanently secured when the workmen left the job on Saturday. During Sunday afternoon a 38-mi. wind, as recorded by the Weather Bureau, came up.

The tower, which was like a steel mast 300 ft. high, fell across a main street and the tracks of the Boston & Maine Railroad, Southern Division. (See views, Figs. 1 and 2.) It struck the track in front of an express train, derailing the locomotive but doing no serious damage.

The failure of the tower is attributed to defects in the guys. The top set of wire guys had not been completed; instead of the permanent set which was to be placed at the top, a temporary set of $\frac{5}{16}$-in. wire guys, and heavy manila rope as auxiliary, had been left in place. Furthermore, the guys had not been made-up tight and the tower was observed to sway excessively just before it fell. The guys broke on the windward side, and the tower fell with some evidence of twisting but no signs of buckling.

As shown by Fig. 2, the tower was composed of angle irons (3x3x$\frac{1}{4}$-in.) for posts and horizontal and diagonal braces (2x2x$\frac{3}{16}$-in.). The braces were spaced 4 ft. apart in the vertical and bolted at each end with a $\frac{7}{16}$-in. bolt. In cross-section the tower was 3½x3½ ft. Three sets of guys were to be used, one at 100 ft. above the base, one at 200 and one at 300 ft. Each set contained three ropes placed 120° apart. There were three concrete anchorages about 150 ft. from the base. The lower guys were ⅝-in. diameter, and the upper ones were to be ¾-in.

The tower was designed by J. R. Worcester, Boston, Mass., and the contract for erection was in the hands of the Builders Iron and Steel Co., Cambridge, Mass., but had been sublet by that company.

It is proposed to start erection again at once, making use of about one-third of the original members. A reinforced-concrete base (see Fig. 1) 5½x5½ ft. and 1 ft. thick, remained rigidly attached to the tower, and without cracking it supported the weight of the tower as thrust upon it during the fall.

*Professor of Civil Engineering, Tufts College, Mass.

New Mississippi River Barges with Deck Gantries

A fresh start has been made in developing transportation on the Mississippi River and its tributaries. The Inland Navigation Co., recently organized under the presidency of John H. Bernhard, has begun the construction of 36 self-propelled shallow-draft steel barges. The first one of the fleet is now nearing completion at the Howard Ship Yards Co., Jeffersonville, Ind.

The barge, built under the regulations of the American Bureau of Shipping, is in all respects of steel construction. Transverse bulkheads divide it into five water-tight compartments. The propelling machinery consists of four three-cylinder oil engines of the four-cycle type, each operating one propeller.

The barges are 240 ft. long and 43 ft. wide over all, with mean draft (at 500 tons' load) of about 3½ ft. and full-capacity draft (at 1,600 tons' load) of about 7 ft. The deck is surmounted by a steel waterproof cargo box having removable sectional roof. Over this an electric traveling gantry is arranged to load and unload cargo, and by means of a 70-ft. extension boom to handle it to and from the bank.

There is the necessary auxiliary electric plant for lighting as well as for cooking, and for all power uses, including winches, steering, etc.

VIEWS OF WRECKED WIRELESS TOWER ACROSS RAILROAD TRACK AT TUFTS COLLEGE, MASSACHUSETTS

1. General view. 2. Detailed view at railroad crossing. From photographs by M. S. Munro

It is expected that these boats will prove so economical in operation that if sufficient advantage is taken of the new line by shippers an important increase in present transportation facilities will result.—John M. Sweeney, Monadnock Block, Chicago.

Water-Supply Improvements for Providence, R. I.

Extensive improvements to the water-supply of Providence, R. I., are to be carried out under direction of a water-supply board established at the last session of the Rhode Island legislature as the result of investigations that have been carried on during the past two years.

The present supply of the city is taken from the Pawtuxet River at Pettaconset, about five miles southwest of the city. While the upper reaches of the Pawtuxet River flow through a sparsely populated farming district, the lower portion of the valley is lined with manufacturing towns. The water is now pumped by electric centrifugal pumps onto sand filter beds, and the filtered water from these beds is pumped to a distributing reservoir, requiring a lift of about 180 ft. Additional pumping of this supply is necessary to reach elevated portions of the city. The new source of supply is demanded, not only because of the serious and increasing pollution of the Pawtuxet River at the point where the city takes its supply, but because at low water the river has a flow of only 12,000,000 gal. per day, while the average consumption of Providence is nearly 20,000,000 gal. per day, with a maximum consumption of over 25,000,000. The numerous milldams in the Pawtuxet above the city's intake also greatly interfere with the regularity of the river flow.

A joint special committee on increased water-supply, of which B. Thomas Potter was chairman, investigated a number of possible sources for future supply, with the assistance of Samuel M. Gray and Frederick P. Stearns as consulting engineers. As a result of these investigations, the north branch of the Pawtuxet River was selected as a future source of supply and the special committee was continued as a board to construct the works it recommended.

It is proposed to build a dam about 80 ft. in height and thus create a large storage reservoir. The drainage basin supplying this reservoir is sparsely populated, nearly all the mills in the river being located lower down on the stream at various falls. Water from this reservoir will be delivered by gravity to the distributing reservoirs in Providence, thus eliminating all but high-service pumping. The conduit to be built will be about 8 ft. in diameter, mostly in tunnel.

The legislative act enabling Providence to build the proposed new works contains an interesting requirement for the maintenance of the flow of the Pawtuxet River. During the period while the reservoir is filling, the city must allow 20,000,000 gal. per day to flow down the stream and may store only the water in excess of such a rate of flow. After the city has accumulated 20,000,000,000 gal. of water in its reservoir, it must draw from the reservoir in each month a quantity equivalent to at least 70,000,000 gal. daily, of which such portion as is required may be devoted to municipal use, the remainder to be discharged into the stream below the dam. Additional provisions are inserted requiring the city to forever discharge from its reservoirs sufficient water to maintain a certain rate of flow at specified milldams and manufactories farther down the stream. At one of these it is required that a quantity of not more than 72,000,000 gal. per week must be delivered as the owner of works shall certify from time to time is necessary for his use for manufacturing purposes other than the production of water power. The city may be required to pay damages to the employees of any manufacturing establishment that is condemned under the act by reason of their loss of employment.

The Providence Water-Supply Board has recently appointed Frank E. Winsor as chief engineer and Samuel M. Gray as consulting engineer. The engineering force for the work is now being selected.

C. & A. R.R. Adopts Automatic Mail Exchange

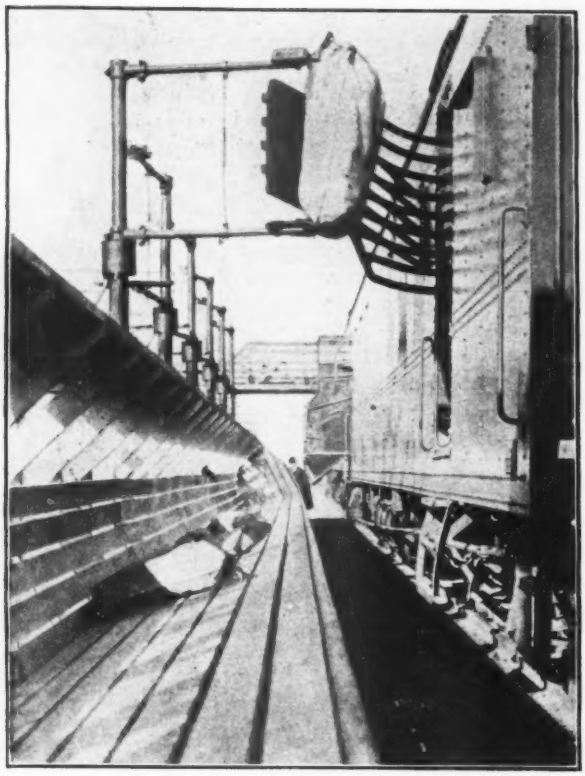
An automatic apparatus for the exchange of mail bags between stations and moving trains has been adopted by the Chicago & Alton R.R. for its line between Chicago and St. Louis. The distance is 284 miles and there are about 35 exchange points.

The station equipment consists of a platform on which are mounted the mail cranes, and beneath which is a trough with floor sloping away from the track. This trough is to receive the bags dropped from the cars, thus reducing the fall and protecting the contents from injury. The trough is about 100 ft. long and 5 ft. wide. The mail cranes are somewhat similar to those ordinarily used, but are set farther from the track and are so made that the arms swing aside when unlatched by the removal of the bag. The crane carries only one bag, but the number of cranes at any point depends upon the amount of mail to be handled, and the train will pick up practically any number of bags in succession.

The equipment on the car includes the mechanism for operating the door, catcher and delivery chute. This is driven by gearing from one of the car axles, but is in operation only while passing an exchange point. It is set in action by a track instrument, or trip, and the corresponding trip on the car is so housed that no obstruction except the track trip can engage it. As soon as the series of motions has been completed the mechanism goes out of action until started again at the next exchange point. The mechanism moves slowly, owing to the use of reducing gear, there being one revolution of the operating shaft to 115 revolutions of the car axle, so that there is no violent shock or slamming in the several movements.

The accompanying figure shows both the station and car equipment with the system in operation. In this view the train has taken five bags and the catcher is just engaging the sixth. At the rear will be seen the mail-delivery compartment projecting from the side of the car and with its bottom chute dropped to deliver the bags to the timber trough.

The track trip is set 456 ft. in advance of the exchange point and starts the mechanism, the operations being controlled by three slowly moving cams. The first cam unlocks and opens the sliding doors while the train travels 180 ft.; it holds them open during a travel of 480 ft. while the bags are taken and delivered, and it then closes and locks the doors during a travel of 180 ft. Thus the



C. & A. TRAIN TAKING AND DELIVERING MAIL

total distance from the time the doors begin to open until they are closed is 840 ft.

The distances given are for cars having 36-in. wheels, but for larger or smaller wheels the track trip is set at the proper distance. When the trip is engaged a gong is sounded in the car, announcing that the exchange is about to take place.

The second cam operates the catcher. This apparatus consists of a curved arm, or chute, to take the bags from the cranes, guide them through the door and drop them upon the floor. This arm, the curved part of which extends inside the car, lies normally against the outside of the car and is swung into catching position (after the doors have been opened) while the train is traveling 180 ft. They are held in this position for a similar distance and then closed, their complete operation being effected during a travel of 540 ft.

The delivery chute is an upright steel compartment, or locker, extending nearly the full height of the side of the car and its outer face forming a part of the side. Within this the mail bags are stacked. The third cam operates this simultaneously with the operation of the catcher. The chute is thrust outward on horizontal guides while the train moves 180 ft. The bottom then drops, forming an inclined apron to deliver the bags into the receiving, or station, trough, which is only a few inches below the level of this apron. The chute is withdrawn into the car and locked in its normal position during a second distance of 180 ft.

Delivering the bags in this way greatly reduces the liability of damage to mail matter (even with parcel-post packages), while it eliminates the present liability of injury to persons being struck by bags thrown out at stations and road crossings. It also eliminates the liability of dropping bags at wrong places, because of mistake or miscalculation of the mail clerk, and the further chance of a bag striking some obstruction and being thrown under its wheels, with consequent loss and damage to the contents or, possibly, derailment of the car.

This mail-exchange system is the invention of Albert Hupp. It is being introduced by the Hupp Automatic Mail Exchange Co., Washington, D. C., and Chicago, Ill.

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A Gasoline-Vapor Explosion Killed 31 and injured 200, and caused property loss estimated at $500,000, in Ardmore, Okla., on Sept. 27. The explosion resulted from a spark from the hammer of a workman engaged in repairing a leak in a tank car. The car is reported to have contained 250 bbl. of gasoline. The spark undoubtedly ignited gasoline vapor in the tank above the liquid. The concussion wrecked two blocks of buildings, and the scattered blazing gasoline started numerous fires. The accident indicates a serious lack of adequate fire-prevention regulations.

The Permit for Building the Coatesville Dam for the improvement of the water-supply of Coatesville, Penn., will not be rescinded by the State Water-Supply Commission, notwithstanding the arguments for such action summarized in "Engineering News" of Sept. 2, page 477.

Experiments on Treating Lake Water with Copper Sulphate to prevent trouble from algae growths were conducted for the City of St. Paul, Minn., from June 12 to Sept. 12, 1915, as recommended by Allen Hazen, consulting engineer, New York City. The work was in the immediate charge of N. L. Huff, Professor of Botany, University of Minneapolis, who will make a report on the subject.

Work on Quebec Bridge continues to make good progress. Since the notes in "Engineering News," Sept. 2, 1915, the fifth main panel on the north cantilever arm has been completed. On the south shore the lower web members are all in and two panels of the upper web members and top chord. The high record noted on p. 473 of the issue of Sept. 2, as 1,240,000 lb. erected in one week should have read "in one day."

Extensive Improvements to the Water-Works of St. Paul, Minn., are soon to be started with the proceeds of a proposed $400,000 bond issue. Plans and specification for a 15,000,000-gal. pumping engine will be ready Nov. 1, so a 4,500,000-gal. pump may be replaced during the winter. By Feb. 1, 1916, plans and specifications will be ready for motor-driven revolving screens, 30,000,000- and 7,000,000-gal. covered reservoirs, and two venturi meters with necessary piping. These improvements are a part of those recommended some months ago by Allen Hazen, consulting engineer, New York City. G. O. House is general superintendent of the St. Paul works.

Plans for Rebuilding the Sewage-Pumping Station of Batavia, N. Y., which was wrecked on Sept. 18, are being made by Chester & Fleming, consulting engineers, Pittsburgh, Penn. The pump well and superstructure will be rebuilt as a structure completely isolated from the water-works and electric-light station, which the old sewage-pumping station adjoined. Electric-driven pumps will be substituted for the old rope-driven pumps, which were put out of commission by the explosion—perhaps only temporarily. The primary explosion may have been caused by striking a match to relight a gas jet between a wooden first, or main, floor and a reinforced-concrete floor below it, for the main floor was forced upward and part of the other floor downward. The forcing upward of a quadrant of the lower floor suggests a second explosion, set off through a stairway leading down to a third landing.

The Railway-Terminal and Grade-Crossing problem at St. Joseph, Mo., has been reported upon at the request of the Commerce Club by Hiram J. Slifer, consulting engineer, of Chicago. The nine railways (trunk and terminal lines) have 33 mi. of main track and 90 mi. of sidetrack, and own or occupy 720 acres of land. There are about 85 regular passenger trains and 60 regular freight trains daily. Within the city limits there are 112 grade crossings (some used by two or more railways), and several of these are in the business district and near the union station. As all the lines enter the city on descending grades, Mr. Slifer advocates track elevation. He proposed to replace the present lines in the heart of the city by a four-track embankment along the water front, with connections at either end to the existing lines and with a new union station at the foot of Francis St., where ample property is owned by the railways. It is proposed that a more detailed study of the project should be made by a commission representing the railways, the State Railway Commission, the city, and the Commerce Club.

PERSONALS

Mr. Alexander J. Taylor, Assoc. M. Am. Soc. C. E., City Engineer of Wilmington, Del., has resigned to join the engineering corps of the E. I. du Pont de Nemours Co. Mr. Taylor has been in the employ of the city for about 16 years.

Prof. G. L. Larson, formerly Professor of Mechanical Engineering at the University of Idaho, and for the last year Fellow in the Department of Steam and Gas Engineering of the University of Wisconsin, has become Associate Professor.

Mr. P. M. Fogg, Assoc. M. Am. Soc. C. E., formerly Project Engineer of the United States Reclamation Service at Lawton, Okla., has entered into partnership with Mr. E. E. Miller, Consulting Engineer, with offices at 1136 First National Bank Building, Denver, Colo.

Mr. Karl R. Kennison, Assoc. M. Am. Soc. C. E., until recently Principal Assistant Engineer to Mr. John R. Freeman, M. Am. Soc. C. E., Consulting Engineer, of Providence, R. I., has been engaged as Assistant Engineer on the staff of the Providence Water-Supply Board.

Capt. James J. Loving, Corps of Engineers, U. S. A., now on duty at Ravenswood, W. Va., in connection with the construction of the locks and dams in the Ohio River, has been transferred to Washington, D. C., where he will relieve Capt. W. D. A. Anderson as Assistant Engineer Commissioner of the District of Columbia.

Prof. Elwood Mead, M. Am. Soc. C. E., Professor of Rural Institutions at the University of California, has been appointed a member of the California Rural Credits Commission. Professor Mead recently returned to this country after a number of years of service as Chairman of the State Rivers and Water-Supply Commission, Victoria, Australia.

Capt. William D. A. Anderson, Corps of Engineers, U. S. A., has been transferred to Panama as Assistant to Colonel Harding on fortification work. He will succeed the late Capt. William F. Endress, who died of pneumonia en route to the United States from Panama. Captain Anderson for the past year has been Assistant Engineer Commissioner of the District of Columbia.

Mr. A. A. Bull, recently associated with the Northway Motor Manufacturing Co., of Detroit, has been appointed Assistant to Mr. Charles S. Crawford, Chief Engineer of the Cole Motor Car Co., of Indianapolis. Mr. Bull is well-known in Great Britain, where previously to coming to America he was connected with Humber, Ltd., and the English branch of the Daimler Co.

Prof. J. G. Callan, formerly associated with the General Electric Co. and later connected with the Arthur Ladder Co., has been appointed Head of the Department of Steam and Gas Engineering of the University of Wisconsin, to take the place of Prof. H. J. Thorkelson, M. Am. Soc. M. E., who has been made Business Manager of the University. Professor Callan was at one time consulting engineer for the City of Boston.

Messrs. A. H. Smith, Assoc. M. Am. Soc. C. E., and L. A. Boulay, who have been associated under the firm name of the Smith & Boulay Co., Consulting Engineers, 320 The Nasby, Toledo, Ohio, announce that beginning Oct. 1 Mr. Smith will conduct an office and business under the name of the A. H. Smith Co., Consulting Engineers, at the foregoing address, and Mr. Boulay under the name of the L. A. Boulay Co., Civil and Sanitary Engineers, 1248 Nicholas Building, Toledo.

Messrs. George H. Frost, Assoc. M. Am. Soc. C. E., formerly President, and Francis W. Frost, formerly Treasurer, of the Engineering News Publishing Co., are now President and Vice-President and Treasurer respectively of Frost & Cundill, Inc. This is only a change in the firm name of Suffern & Co., 64 Wall St., New York City, and does not in any way affect the policy of the company or the personnel of its management. The company does an export and import business.

Messrs. A. V. Kieslich and Oscar Heininger, of Burlington, Vt., and A. H. Heininger, of Boston, have formed an engineering and contracting firm known as the Kieslich Construction Co., with offices at Burlington. Mr. Kieslich for 10 years has been in engineering and contracting work about New England and retires from the firm of Elliott & Kieslich, of Burlington. Mr. Oscar Heininger has been connected with the Burlington Water-Works Department for over 30 years. Mr. A. H. Heininger for seven years has been with the sales department of the Boston Edison Illuminating Co.

Prof. Albert Victor Bleininger, who has been in charge of the Ceramic Section of the U. S. Bureau of Standards at Pittsburgh since 1912, has been appointed Professor and Head of the Department of Ceramic Engineering of the College of Engineering of the University of Illinois. After graduation from Ohio State University in 1901, Mr. Bleininger was in turn Instructor, Assistant Professor and Associate Professor of Ceramics in that institution, leaving there in 1907 to become Professor of Ceramics in the University of Illinois. The next year he was in charge of the Clay Products Laboratory of the U. S. Geological Survey, and two years later became Professor and Director of the Department of Ceramics at the University of Illinois, which appointment he resigned to become associated with the Bureau of Standards.

Mr. C. Stanley Sale, formerly Secretary and General Manager of the Engineering Publishing Co., of Indianapolis, and more recently Editor for the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals, has been appointed Assistant to the Director of the Engineering Experiment Station and Instructor in Civil Engineering of the University of Illinois. Mr. Sale graduated from Purdue University in 1906 and was Assistant Engineer of the Florida East Coast Railway until 1907, at which time he became Associate Editor of the "Railway Age Gazette." Two years later he entered the employ of the Blount Plough Works, of Evansville, Ind., as Sales Manager, and the following year was made Business Manager of the Municipal Engineering Co., of Indianapolis, which connection he severed in 1912, when he joined the staff of the Engineering Publishing Co.

OBITUARY

John T. Johnson, General Superintendent of the Central Georgia Ry., died at Savannah, Ga., on Sept. 22.

Oscar G. Higgins, Chief Engineer of the Royal Baking Powder Co., died recently at his home in Brooklyn, N. Y., at 60 years of age. He was a native of Boston.

G. H. Williams, of Cleveland, Ohio, President and Treasurer of the G. H. Williams Co., of Erie, Penn., was killed on Sept. 25 in an automobile accident whech occurred at Harbarger Crossing, one mile west of Erie.

Fields C. Pendleton, of Brooklyn, N. Y., a member of the firm of Pendleton Bros., ship brokers, of New York City, and a master mariner and shipbuilder, died on Sept. 22 at Isleboor, Me., his birthplace.

Robert S. Greenleaf, an engineer formerly on the staff of the Oregon-Washington Railway and Navigation Co. and well-known in the State of Oregon, died at his home in Portland, Ore., on Sept. 2, at 67 years of age. He was born in St. Louis and served throughout the Civil War. In 1884 he went to Oregon and entered the service of the Oregon-Washington Co.

Maximilian Lewinson, M. Am. Soc. C. E., President of the contracting firm of Lewinson & Co., of New York City, died suddenly at his home in Scarsdale, N. Y., on Sept. 19. He was born in Poland and came to America 35 years ago. He began his career in this country as a civil engineer in the employ of Mr. Leopold Eidlitz, Sr., of New York City. He was in his 61st year.

Charles Edwin Williams, founder and senior member of the firm of Williams, McNaughton & Bapst, contractors, of Buffalo, N. Y., died at his home in that city on Sept. 22. Mr. Williams was born in Buffalo in 1852 and after leaving school he entered the office of his father, a general contractor. Later, he took an engineering course at the Polytechnic Institute of Stuttgart, Germany, and on returning to Buffalo entered the general contracting business, from which he retired in 1909. One of the most notable pieces of work which Mr. Williams executed was the government breakwater at Buffalo in 1885. He was also President of the German Rock Asphalt and Cement Co.; Vice-President of the Buffalo Dredging Co.; President of the Buffalo Northern Realty Co., and President of the North Collins Fuel and Gas Co.

Cornelius J. Field, formerly Chief Engineer and Superintendent of the Edison Electric Illuminating Co. of Brooklyn, N. Y., and widely known through his association with Thomas A. Edison in the development and adoption of the electric motor omnibus in this country, died at his home in Brooklyn from typhoid fever on Sept. 25. Mr. Field was the first Chief Engineer of the old Edison United Manufacturing Co. and superintended the construction of the first central station for the distribution of electrical energy in Brooklyn. He built

the electric street-railway systems in the cities of Buffalo, N. Y.; Newark, N. J.; Worcester, Mass.; Bridgeport, Conn.; Philadelphia, and other cities in the Eastern States, and did considerable construction work of the same kind in Europe. He constructed many miles of railway and several large sugar plants in the West Indies and at the time of his death was interested in engineering work for English sugar concerns in Cuba.

ENGINEERING SOCIETIES

COMING MEETINGS

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 5-7. Annual meeting at Chicago. Secy., C. B. Edwards, M. & O. R.R., Mobile, Ala.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 19-21. Annual meeting, at Detroit, Mich. Secy., C. A. Lichty, 319 N. Waller Ave., Chicago.

SAN FRANCISCO MEETINGS

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

American Society for Testing Materials—The letter ballot on the amendment of the by-laws, the revision of certain standards and the adoption of new standards, canvassed on Aug. 21, resulted in an affirmative vote on every item. The list of standards as revised includes 88 titles, as compared with last year's 70.

Engineers' Club of Kansas City, Mo.—Arrangements have been made with Maj. S. A. Cheney, Instructor in the School of Engineers, Fort Leavenworth, Kan., to give a course of lectures and lay out a reading course for interested members of the club who desire to take up the same during the coming winter. The subject will of course be military engineering, and the method of presentation will be designed to enable the men to qualify as officers in volunteer army organizations.

International Irrigation Congress—At the 22nd Congress, which was held at Stockton, Fresno, Sacramento and San Francisco, Sept. 13-20, the Engineering Section elected as Chairman for the ensuing year, F. C. Herrmann, Consulting Engineer for the Modesto Irrigation District, Merchant's Exchange Building, San Francisco. Richard F. Burges, El Paso, Tex., was elected President of the Congress; J. S. Dennis, Calgary, Alberta, First Vice-President; and Arthur Hooker, Fresno, Calif., was reëlected as Secretary. Resolutions were adopted in favor of rural credits and aid in land settlement; a national marketing commission; the completion of "meritorious" irrigation "projects outside of those begun by the Reclamation Service"; state control of irrigation districts and of private irrigation projects; revision of Reclamation-Service costs; Federal, state and provincial appropriations for stream gagings and for irrigation and drainage investigations; favorable consideration by Congress of the Newlands-Broussard bill for river regulation and control and the fullest possible use of the water resources of the West; and the appointment of a committee to report on permanent headquarters for the Irrigation Congress.

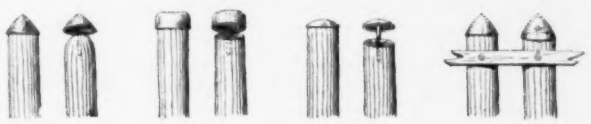
Appliances and Materials

Electrically Driven Fire Pumps

A line of centrifugal fire pumps with their shafts connected to an electric motor on the same bedplate is being introduced by the Hill-Tripp Pump Co., of Indianapolis, Ind., and has been approved by the Fire Underwriters' Associations, being equipped with the special fire-service fittings required by these associations. The discharge elbow, with manifold, hose valves, relief valves, etc., is supported on a pedestal adjacent to the bedplate. The pump is built in sizes of 500 to 1,500 gal. per min. capacity, with motors of 50 to 125 hp. respectively. The pressure is 100 lb. per sq.in. for all the pumps.

Permanent Iron Caps for Protecting Timber Piles

A variety of pile caps devised by Oscar A. Logan, 261 Broadway, New York City, are shown in the accompanying sketches. No. 1 is recommended for protecting old piles with rounded tops. Cap No. 2 is designed for new work. Cap No. 3



FOUR DESIGNS OF IRON PILE CAPS

is recommended for placing on bunched piles. The caps are made of cast iron with wrought-iron spindles 1 in. in diameter and 8 in. long. No. 1 weighs 50 lb.; No. 2 weighs 60 lb., and No. 3, 17 lb. Pressed-steel caps can be furnished, but are not recommended. The fourth sketch shows a modified fastening.

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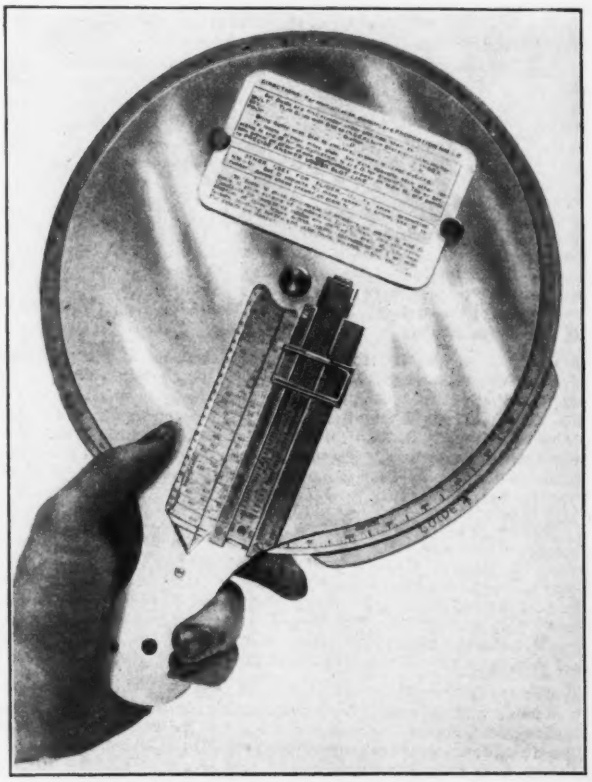
New Graduated-Spiral Slide-Rule

A slide-rule that may be directly read to four places and estimated to a fifth has been put on the market under the name of the Ross Precision Computer. It is designed to be particularly useful for engineering computations, and is the invention of Louis Ross, of San Francisco, who invented and now manufactures the "Meridiograph," described in "Engineering News," Feb. 26, 1914. The new device is manufactured by the Computer Manufacturing Co., 268 Market St., San Francisco.

The logarithmetic graduations are along a 29-ft. spiral on a disk about 8 in. in diameter. The outside ring of



ROSS PRECISION COMPUTER—A SLIDE RULE WITH GRADUATION ON A SPIRAL

graduations is a scale of equal parts for addition and subtraction. The operations of multiplication and division are as simply performed as with any logarithmic scale. The auxiliary 4-in. slide-rule on top gives logarithmic numbers on the left-hand fixed scale and corresponding square and cube roots on the right-hand fixed scale. On the slide between are two logarithmic scales, both corresponding to the left-hand fixed scale but graduated in reverse directions. The computer is made of aluminum and german silver.